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SOME ASPECTS IN THE ECOLOGY OF THE BLACK BEAR (*URSUS AMERICANUS*) IN INTERIOR ALASKA

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IN INTERIOR ALASKA

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OF THE BLACK BEAR (URSUS AMERICANUS)

IN INTERIOR ALASKA

A

THESIS

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ABSTRACT

Research during 1964 and 1965 revealed that black bears in interior Alaska are active only 5 to 5.5 months each year. Emerging from winter dens in early May, the animals spend most of the first 3 months in river bottom and other lowland situations where green vegetation, especially *Equisetum* spp., composes the bulk of their diet. From the last half of July until mid-September bears are observed most commonly in alpine areas where fruits, especially *Vaccinium uliginosum*, are the important food. Animal food, constituting less than 15 percent (volume) of the animal's diet, is apparently taken whenever it is obtainable. Most animal food occurrences involve insects.

Litter size averaged 1.73 for 30 litters observed during the 2 years studied. Litters larger than two do not seem to be common in interior Alaska. Intestinal parasites were found in 12 of 16 bears. Two heavy infestations of ascarids, 249 worms in one bear and 53 in another, were observed. Serious predation by interior Alaskan black bears upon the nests of some waterfowl has been recorded; predation upon most other wildlife species appears to be negligible. Evidence gathered during this study suggests that the rash of black bear problems experienced by interior Alaskans in 1963 was due largely to the widespread lack of blueberries during that year.

PREFACE

During the summer of 1963, an epidemic of black bear problems in interior Alaska attracted considerable attention. Though many people felt that a poor blueberry crop was responsible, biologists were reluctant to commit themselves to explanations because of a recognized lack of evidence. As stated by Erickson and Rausch (1964), "Unfortunately, very little is known of the food habits of the black bears in interior Alaska,...." Thus, the primary objective of this study was to determine basic food habits patterns; at the same time, it was hoped that data could be gathered on other phases of black bear ecology in this, the extreme northern edge of the animal's range.

Field work was conducted during the bear activity seasons of 1964 and 1965. The investigation was financed by funds from Federal Aid to Wildlife Restoration, Alaska projects W-6-R-6 and W-15-R-1 through the Alaska Cooperative Wildlife Research Unit.

I would like to express my indebtedness to a number of people whose assistance proved valuable during this study:

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

THE STUDY AREA

The study area includes 99,000 km^2 (about 38,000 square miles) of interior Alaska bounded on the east by the Alaska-Canada border, on the north and west by the Yukon River, and on the west by the Tanana River, although most research effort was necessarily expended in a few of the more accessible areas indicated in Figure 1.

Much of this area is occupied by the relatively low, rolling hills of the Yukon-Tanana upland. These hills, few of which rise above 1,220 m in elevation, extend from Canada west to the confluence of the Yukon and Tanana Rivers, thus separating the drainages of these two large interior Alaskan waterways. The basins of the Yukon and the Tanana consist of wide flood plains marked by numerous meandering streams, ponds, swamps, and marshes.

The climate of this region is described as strongly continental by Watson (1959) who provides the following supporting information. Extreme temperatures and low precipitation are the rule. The highest temperature on record in the area is 100° F (37.8° C) at Fort Yukon (6-27-1915). The record low in the area, also at Fort Yukon, is -75° F (-59.4° C), only slightly warmer than the all-time Alaskan

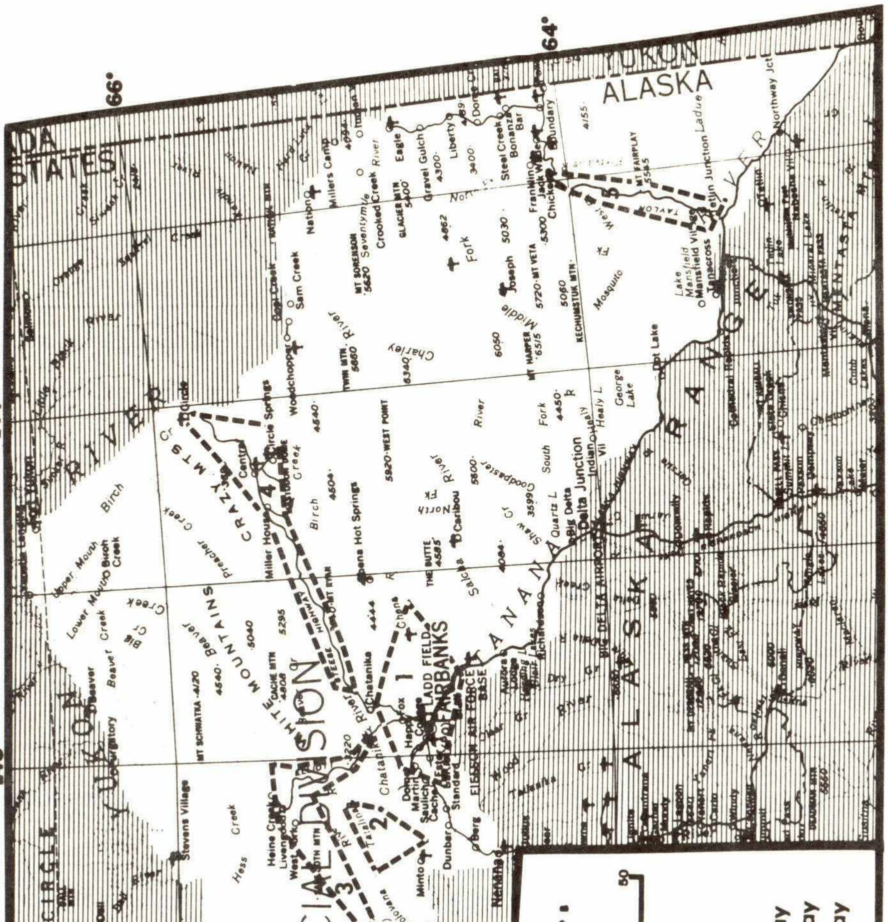

Figure 1. Map of the study area (unshaded) in interior Alaska. Most research activities were conducted in the five smaller areas indicated.

low of -76° F (-60° C) at Tanana in January of 1886. Mean annual precipitation in the area varies locally from less than 10 inches (25 cm) to about 15 or 16 inches (40 cm) while snowfall averages 3 to 5 feet (1 to 1.5 m). The frost-free season is very short, beginning in late May and ending in late August in the lowlands.

Though interior Alaska is arid in terms of amount of precipitation, a variety of circumstances combine to hold much of the available moisture at or near the ground surface. Among these, as discussed by Drury (1952), are poor surface drainage due to the flat surfaces of the lowlands and gentle slopes of adjoining uplands, poor percolation through the fine-grained alluvial and wind-blown deposits which cover much of the region, and retarded sub-surface percolation over the permafrost (perennially frozen ground), which lies at varying depths under all but a few favorably exposed sites. Spongy vegetation, consisting largely of mosses, is common at the soil surface and its water-holding and insulating characteristics serve to compound the effects of the phenomena already mentioned. A detailed treatment of soil types in the area, particularly as they relate to forest types, is given by Wilde and Krause (1960).

Table 1 lists the major environmental types on the study area as determined in the intensive ecological survey made by Buckley and Libby (1957). Coniferous forests

Table 1. Abundance of major environmental types in the study area. (After Buckley and Libby, 1957)*

Type	Number of Plots	Percent of Total Plots
Forest	1,281	66.61
Tall Brush	140	7.28
Dwarf Brush	259	13.47
Herb	137	7.12
Aquatic	53	2.76
Bare	53	2.76
Total	1,923	100.00

*My study area composes approximately the southern one-half of the area represented in the above sampling. It is probable that the forest category would occupy a somewhat larger portion of my area than it does of the total area represented here and the other types would be correspondingly smaller.

occupy nearly 60 percent of the total forest area. About three-fourths of this is white spruce (*Picea glauca*)* forest which, with its usual understory of alder (*Alnus* spp.) or willow (*Salix* spp.) and its ground cover of mosses, is apparently of little importance as feeding habitat for black bears.

Most of the remaining one-fourth of the coniferous forest area occurs on poorly-drained areas, including muskeg, and is characterized by sparse black spruce (*Picea mariana*) and some larch (*Larix laricina*). With blueberry (*Vaccinium uliginosum*) common on the forest floor, this type is fairly important to bears, especially in early fall.

About 10 percent of the forest area is deciduous forest composed of white birch (*Betula resinifera*), aspen (*Populus tremuloides*), some cottonwood (*Populus tacamahacca*) and various mixtures of these species. Occurring on well-drained sites, often on south-facing slopes, the deciduous type supports a number of items on the forest floor which are important to bears, notably lowbush cranberry (*Vaccinium vitis-idea*), highbush cranberry (*Viburnum*

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*Common and scientific names of plants follow the usage of Anderson (1959). Those of mammals follow Hall and Kelson (1959) with the exception that the scientific name of the brown-grizzly bear complex follows Rausch (1963). Bird names follow the check-list of the American Ornithologists' Union (1957).

edule), rose (Rosa acicularis) and horsetails (Equisetum arvense, E. pratense, and E. sylvaticum).

Mixed forest, largely white spruce-white birch and white spruce-aspen, makes up about 20 percent of the total forest area. Many of the items important to bears mentioned above, including high bush cranberry, rose, and horsetails, also occur in this type, though to a lesser extent.

The remaining forest area has recently been burned over and now supports, largely, willows, alders, and dwarf birch (Betula glandulosa). Fireweed (Epilobium angustifolium) is the most abundant herb in the burns. Many of the older burns produce excellent crops of blueberries and are much used by bears in the fall.

Tall brush, consisting of shrubby growth 2.5 feet (about 76 cm) or more in height, occurs mainly at the lower elevations and particularly on alluvial sites and in riparian situations. It is an important cover type for bears when they are using streamside vegetation such as horsetails and some of the Graminoids. Willows, alders, and saplings of aspen, cottonwood, and birch are common components of this type.

Some of the same species of shrubs, growing in less favorable (frequently higher elevation) situations, compose the dwarf brush type (shrub growth less than 2.5 feet high). In addition, this type supports many heaths such as

Labrador tea (*Ledum* spp.), blueberry, lowbush cranberry, and crowberry (*Empetrum nigrum*). Occurring mostly at elevations above 765 m, this type is particularly important to bears during the berry season.

The herb environmental type includes marshes, meadows, and alpine tundra. Sedges, particularly *Carex* spp. and *Eriophorum* spp., dominate in marsh and wet tundra situations with the horsetails, *Equisetum limosum* and *E. palustre* locally important in some of the marshes. In meadows, which occur mainly on alluvial sites, sedges give way to grasses, especially bluejoint (*Calamagrostis canadensis*). Dry alpine tundra is characterized by sedges, alpine bearberry (*Arctostaphylos alpina*), lichens, and mountain avens (*Dryas* spp.). This well-drained to arid alpine situation comprises nearly 75 percent of the total herb type. Wet alpine tundra occurs in about 15 percent of the herb type, and the remainder is divided fairly evenly between marshes and meadows. These last two sub-types, particularly marshes, are the herb types most used by black bears.

Aquatic sites include all open water whether stream, river, lake or pond. Sub-surface vegetation is not considered. With respect to water, it should be mentioned that though salmons (*Oncorhynchus* spp.) and sheefish (*Stenodus leucichthys*) do reach waters of the study area in their inland migrations, in most years they are relatively few in number and are not readily available to bears.

Bare sites, those devoid of vegetation, occur at all elevations, although the greater proportion lie above 1,000 m. They include talus slopes, rock outcrops, permanent snow banks, and newly established river bars.

Overall, as pointed out by Lutz (1956), the pattern of forest and vegetation in interior Alaska is a complex mosaic of types, with exposure, elevation, extent of drainage, and fire among the factors contributing to the pattern. The area, as black bear habitat, contrasts greatly with other Alaskan areas in its wetness of ground despite low precipitation, its relatively simple plant associations, its comparatively short snow-free season, and in its lack of great runs of fish.

FOOD HABITS

Materials and Methods

The specimen material used in this study includes 23 stomachs, 16 intestinal tracts, and 44 scats collected during the periods of bear activity (essentially early May through early October) of 1964 and 1965. In the interior of Alaska, the annual activity period is characterized by two general seasons of plant food availability. During the first, which begins when the bears emerge from their winter dens and ends in mid-July when fruits are beginning to ripen, green vegetation is the most abundant, potential food material. This entire season (arbitrarily, through 15 July) will be designated as "spring" throughout this paper. The second season, designated as "fall" in this paper, begins during the second half of July and continues until the bears once again retire for the winter. Obviously, this is the period during which fruit is the important food. The specimen material enumerated above is divided very nearly equally between spring and fall, as shown in Table 2.

Table 2. Temporal and spatial distribution of black bear food habits specimen material, 1964-1965, interior Alaska.

Location	Speci-men*	Spring			Fall			Total For Area
		1964	1965	Total	1964	1965	Total	
Fairbanks Area	ST	1	1	2	3	1	4	6
	IN	1	0	1	3	0	3	4
	SC	0	1	1	5	0	5	6
Minto Flats	ST	0	2	2	0	0	0	2
	IN	0	1	1	0	0	0	1
	SC	0	0	0	0	0	0	0
Upper Elliott Highway	ST	2	2	4	2	1	3	7
	IN	1	1	2	2	1	3	5
	SC	1	1	2	7	3	10	12
Upper Steese Highway	ST	0	2	2	3	1	4	6
	IN	0	2	2	1	1	2	4
	SC	0	10	10	8	5	13	23
Lower Taylor Highway	ST	0	2	2	0	0	0	2
	IN	0	2	2	0	0	0	2
	SC	3	0	3	0	0	0	3
Totals, All Areas	ST	3	9	12	8	3	11	23
	IN	2	6	8	6	2	8	16
	SC	4	12	16	20	8	28	44

*Specimen: stomachs (ST), intestines (IN), and scats (SC).

Field Techniques. Stomachs and intestinal tracts were obtained from bears killed by hunters and, in three instances, from bears collected by the author. The loss of seven intestinal tracts was attributable to the activities of bird and mammal scavengers in three cases and to logistics in four cases.

After removal of the alimentary tract from the animal, the stomach and intestines were separated at the pyloric connection, wrapped separately in cheesecloth, and preserved in 10 percent formalin. Because bears commonly chew and swallow vegetation and debris while dying from gunshot wounds, the entire esophagus was always discarded.

Scats were collected only if they could be fairly confidently dated. This included those which retained sufficient moisture to be obviously fresh and those which had been deposited in a given area less than 10 days after an earlier visit I had made to the area. To prevent over-representation of any one time or place, multiple finds (for example the 11 scats found within an area of less than 50 m diameter in one instance) are treated as one scat. It wasn't possible, in many cases, to determine with certainty that scats had been deposited by black bears and not by grizzly bears (*Ursus arctos*). However, grizzlies were not common in any of the areas in which I worked; I saw none and I saw definite sign (tracks) only once. I am confident that most, if not all, of the scats in my sample are black bear scats.

The first seven scats collected were oven-dried and stored in cheesecloth. All others were put into plastic bags, covered with isopropyl alcohol, and stored in glass jars.

Laboratory Techniques. Stomach contents were washed in cold water, pressed and drained on 1/16 inch (about 1.6 mm) mesh screen, and spread out to a depth of about 15 mm on flat pans for analysis. Whenever feasible, individual items were separated out completely. Otherwise, separation continued until a homogeneous appearing matrix remained. Whenever possible, five 50 cc samples were taken from this matrix for further analysis; for a few stomachs containing small total volumes, the sample size was reduced to 25 or 30 cc, and the number of samples was reduced in some cases.

Samples were floated in 5 to 10 cm of water and again items were segregated as completely as possible. After separation, all items were measured volumetrically in graduated cylinders. When more than one green vegetation item occurred in the same stomach, complete segregation even in the samples was rarely feasible. In these cases, an ocular estimate of the relative amounts of each item in the green portion was necessary. Total stomach volume was taken as the sum of the volumes of the items separated out at first, the samples, and the remaining matrix.

Intestinal contents were washed vigorously under a strong jet of water to loosen seeds, bone, and other dense items which subsequently sank to the bottom of the container. These were examined and identified. The remaining, lighter materials were decanted, drained, and spread out in much the same manner as were stomach contents, and these materials were then searched until it was believed that all items had been identified. Finally, a percentage volume was assigned to each item by ocular estimate.

Procedures for scat analysis were exactly the same as those for analysis of intestinal contents except that volume estimates were limited to six categories: trace (less than 1 percent), 1-5 percent, 6-25 percent, 26-50 percent, 51-75 percent, and 76-100 percent.

Most examination and separation of materials was done macroscopically. Occasionally a binocular dissecting microscope was used to aid in volume estimates of fine, mixed vegetation and in identification of berries and seeds. The binocular microscope was used extensively in identification of green vegetation items. A compound microscope at low power was used in a few cases to aid in identification of hairs. Identifications were verified by comparison with collections made during the field seasons in the case of fruits, comparison with known specimens from the University of Alaska Museum in the case of mammals and birds, and comparison with pressed specimens from the University of Alaska Herbarium and consultation with local botanists in the case of green vegetation.

Results

Figures 2 and 3 depict the relative importance of major food categories by frequency of occurrence and by aggregate percentage volume respectively during each of the two seasons of bear activity. Table 3 provides a seasonal comparison of frequency and quantitative information for individual food items found in stomachs, intestines and scats. Table 4, a list of trace items with low frequencies of occurrence, supplements Table 3.

<u>Green Vegetation</u>. Green plant material proved to be, by far, the most important component of the spring diet of black bears in interior Alaska. Various unidentified

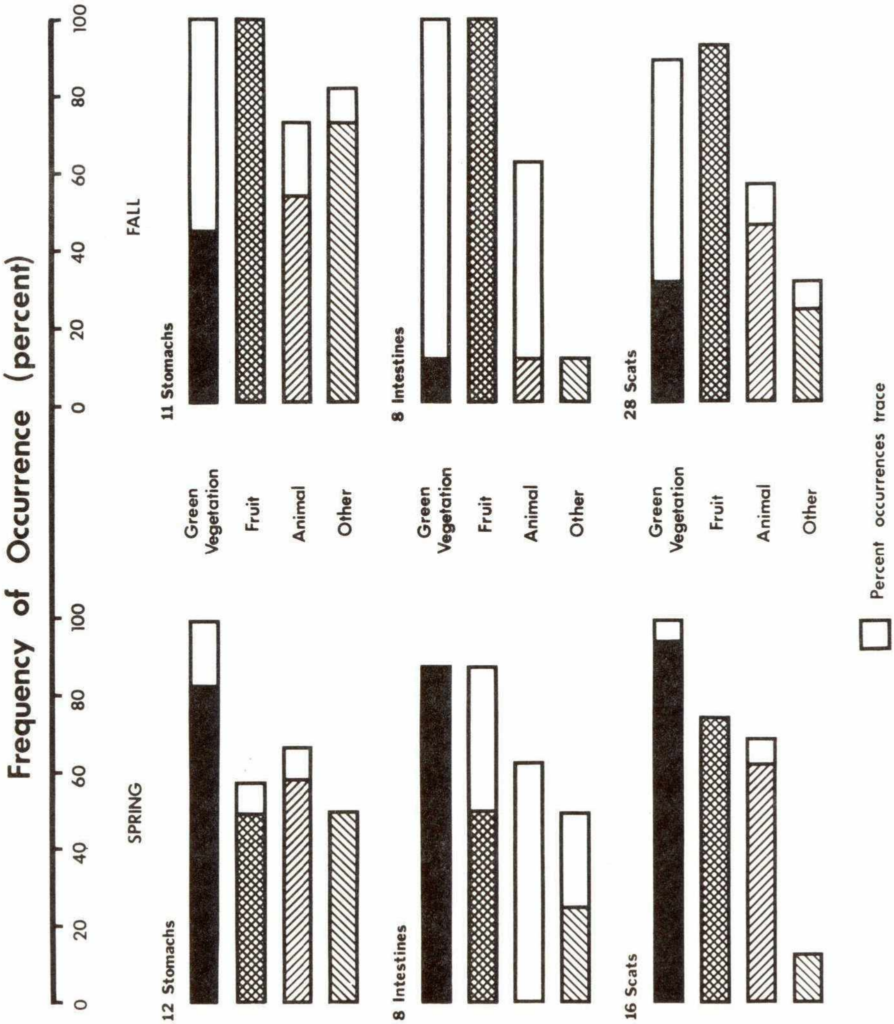


Figure 2. Frequency of occurrence of major black bear food materials in interior Alaska, 1964-65. The proportion of all occurrences which were at the trace level only is depicted visually for each food category. The associated numerical values, expressed as a percentage of the occurrences for each category, are listed in Table 3. The actual frequencies of trace occurrences may be read directly from the scale shown.

Figure 3. Percent volume occupied by each of four main food categories in the diets of interior Alaskan black bears, 1964-65. Major individual items in each category, together with their volumetric contributions, are shown above each bar chart.

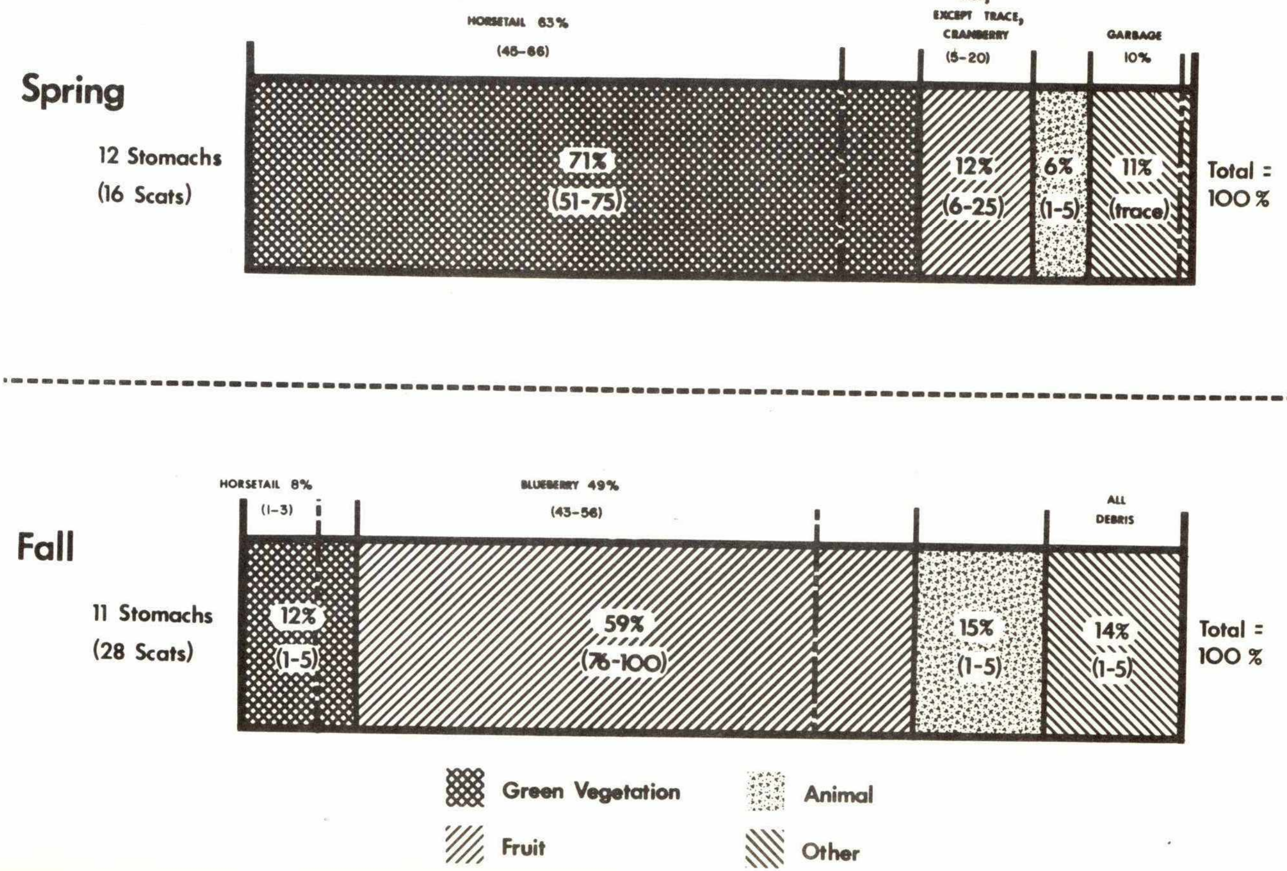


Table 3. Foods consumed by black bears in interior Alaska, 1964-1965.[a]

Food Item	23 Stomachs			16 Intestines			44 Scats		
	Freq. (Percent)	Percent Trace[b]	Mean Percent Vol.[c]	Freq. (Percent)	Percent Trace	Mean Percent Vol.	Freq. (Percent)	Percent Trace	Mean Percent Vol.
GREEN VEGETATION	100	17	71.0	88	0		100	6	51-75
	100	45	12.0	100	88		89	64	1-5
Equisetum spp.	92	9	61.8	63	40	83.7	94	0	51-75
	45	20	36.2	25	50	27.5	21	17	26-50
Gramineae	33	0	12.0	38	0	44.0	44	43	1-5
	27	33	1.6	0			39	64	6-25
Polygonum	17	50	2.4	13	0	10.0	0		
	0			0			0		
Lupinus arcticus	8	100	trace	0			0		
	36	50	12.0	37	100	trace	18	80	1-5
Pedicularis spp.	17	0	16.0	13	0	65.0	0		
	9	100	trace	0			0		
Galium boreale	17	0	10.2	33	0	15.0	0		
	0			0			0		

[a]The upper row of figures for each food item constitutes spring findings; the lower row shows fall data.
[b]Percent of all occurrences which were at trace level only (less than 1 percent by volume).
[c]The average percentage volume for those occurrences greater than trace.

Table 3. (Continued)

Food Item	23 Stomachs Freq. (Percent)	23 Stomachs Percent Trace	23 Stomachs Mean Percent Vol.	16 Intestines Freq. (Percent)	16 Intestines Percent Trace	16 Intestines Mean Percent Vol.	44 Scats Freq. (Percent)	44 Scats Percent Trace	44 Scats Mean Percent Vol.
unident. green	8	0	38.0	38	33	23.0	6	0	26-50
	9	100	trace	0			0		
Ledum decumbens	42	100	trace	13	100	trace	31	100	trace
	82	100	trace	87	100	trace	39	100	trace
Betula glandulosa	8	100	trace	0			6	100	trace
	64	100	trace	50	100	trace	14	100	trace
Salix spp.	8	100	trace	25	100	trace	13	100	trace
	18	100	trace	13	100	trace	18	80	1-5
Picea spp.	50	100	trace	50	100	trace	56	100	trace
	27	100	trace	13	100	trace	39	100	trace
Populus tremuloides	8	100	trace	25	100	trace	0		
	0			0			14	75	1-5
Betula resinifera	0			0			13	100	trace
	9	100	trace	13	100	trace	11	100	trace
Compositae	0			13	0	15.0	0		
	0			0			0		

Table 3. (Continued)

Food Item	23 Stomachs Freq. (Percent)	23 Stomachs Percent Trace	23 Stomachs Mean Percent Vol.	16 Intestines Freq. (Percent)	16 Intestines Percent Trace	16 Intestines Mean Percent Vol.	44 Scats Freq. (Percent)	44 Scats Percent Trace	44 Scats Mean Percent Vol.
<u>Carex</u> spp.	0			0			6	100	trace
	0			0			7	50	1-5
Musci	8	100	trace	0			0		
	9	100	trace	0			7	50	1-5
FRUIT	58	14	12.0	88	43		75	0	6-25
	100	0	59.0	100	0		93	0	76-100
<u>Vaccinium</u> <u>uliginosum</u>	17	100	trace	38	100	trace	13	50	76-100
	100	9	49.9	100	13	78.0	79	0	51-75
<u>Vaccinium</u> <u>vitis-idea</u>	58	14	22.5	88	14	53.3	75	8	6-25
	64	86	10.4	50	75	23.0	39	36	51-75
<u>Rosa</u> <u>acicularis</u>	17	100	trace	13	100	trace	0		
	73	38	24.8	75	83	80.0	29	13	6-25
<u>Empetrum</u> <u>nigrum</u>	0			38	33	7.5	6	0	1-5
	36	25	8.0	75	50	33.3	25	50	6-25
<u>Viburnum</u> <u>edule</u>	8	100	trace	13	100	trace	0		
	18	0	4.3	25	50	15.0	18	0	6-25

Table 3. (Continued)

Food Item	23 Stomachs Freq. (Percent)	23 Stomachs Percent Trace	23 Stomachs Mean Percent Vol.	16 Intestines Freq. (Percent)	16 Intestines Percent Trace	16 Intestines Mean Percent Vol.	44 Scats Freq. (Percent)	44 Scats Percent Trace	44 Scats Mean Percent Vol.
Arctostaphylos uva-ursi	17	100	trace	13	0	8.0	0		
	9	100	trace	0			14	50	6-25
Arctostaphylos alpina	0			0			0		
	0			0			18	40	1-5
Ribes triste	0			13	100	trace	0		
	9	100	trace	13	100	trace	11	67	6-25
ANIMAL FOOD	67	13	6.0	63	100		69	9	1-5
	73	25	15.0	63	80		57	19	1-5
Lepus americanus	33	0	13.4	50	100	trace	38	0	6-25
	45	40	5.6	13	100	trace	36	20	6-25
Alces alces	8	0	2.5	0			0		
	18	50	43.7	0			14	50	6-25
Synaptomys borealis	8	0	1.7	0			0		
	0			0			0		
Zonotrichia leucophrys	0			0			0		
	9	0	1.6	0			0		

Table 3. (Continued)

Food Item	23 Stomachs			16 Intestines			44 Scats		
	Freq. (Percent)	Percent Trace	Mean Percent Vol.	Freq. (Percent)	Percent Trace	Mean Percent Vol.	Freq. (Percent)	Percent Trace	Mean Percent Vol.
<u>Bucephala</u> sp.	8	0	2.1	0			0		
	0			0			0		
<u>Ixoreus</u> <u>naevius</u>	8	0	1.1	0			0		
	0			0			0		
Formicidae	33	50	11.6	13	100	trace	31	0	6-25
	27	67	1.4	0			11	33	6-25
Vespidae	8	100	trace	0			0		
	45	20	17.5	63	80	5.0	18	20	1-5
Cynipidae	0			0			0		
	9	0	3.6	0			0		
OTHER	50	0	11.0	50	50		13	100	trace
	82	11	14.0	13	0		32	22	1-5
Garbage	25	33	93.3	38	67	3.0	6	100	trace
	9	0	10.8	0			18	60	26-50
Debris	33	0	5.6	13	0	20.0	6	100	trace
	64	14	16.0	13	0	28.0	18	0	6-25

Table 4. Black bear food items occurring three times or less, and only at the trace level.

	NUMBER OF OCCURRENCES				
	Stomachs		Scats		
Food Item	Spring	Fall	Spring	Fall	Total
PLANT FOOD					
Ranunculaceae	1				1
Rosaceae (greens)	2		1		3
lichens	1			1	2
ANIMAL FOOD					
Lemmus trimucronatus				1	1
unident. bird			1		1
Osteichthyes	1				1
Culicidae	1	1	1		3
Bombidae (?)			1	1	2
Coleoptera	1				1
Lepidoptera				1	1

Note: There were no occurrences of this type in the intestinal samples.

grasses (Gramineae) were common, and the shoots and succulent stems of wild rhubarb (*Polygonum alaskanum*), and the young stems and leaves of northern bedstraw (*Galium boreale*) and lousewort (*Pedicularis* spp.) occurred occasionally. But horsetails, present in 86 percent of the spring sample units and representing a large proportion of the total contents, composed the real staple during this season. The largest stomach examined contained nearly 5 liters of shoots and young stems from the swamp horsetail (*Equisetum limosum*). The bear involved, a large male, was standing in about 50 cm of water feeding on this emergent plant when shot. A number of reports of other bears standing belly-deep in swamp water "feeding like moose," indicates that this wasn't an exceptional case. *E. limosum* was identified in the digestive tracts of two bears and in one scat, all collected in May, and composed 90 percent or more, by volume, of each occurrence.

All other occurrences of *Equisetum* were from samples collected in non-marsh situations and involved the common horsetail (*E. arvense*) or the meadow horsetail (*E. pratense*) or both. Distinction between these two species among the food habits material could not be made with certainty. However, on the basis of silica spicule characteristics as described in Fernald (1950), approximately 50 percent of these occurrences probably involved the former only, and the rest involved either or both. This _E. arvense-pratense_ complex, then, comprised the most used spring food and it continued to be important through the first two or three weeks of the fall season. With respect to fall, the leaves of arctic lupine (_Lupinus arcticus_) proved to be the only other green item of even minor importance.

A number of items such as the leaves of Labrador tea (_Ledum decumbens_), dwarf birch, and willow, and the needles of spruce had high frequencies of occurrence, particularly in the fall, but nearly always occurred at the trace level. These are believed to have been ingested incidentally to other foods, especially berries.

Fruits. Among the various fruits available in interior Alaska, two species of _Vaccinium_ (blueberry and low-bush cranberry) are the most important to bears. The latter overwinters well and contributes much to the spring diet in some areas. In addition, in the late fall cranberries become important after the first few frosts. (Freezing effectively reduces the availability of blueberries and probably increases the sugar content of the cranberries themselves.) But, blueberries, when they are available, seem to be by far the most important food as evidenced by the fact that they were found in the digestive tracts of all fall bear specimens examined and occurred in nearly 80 percent of the scats collected during the fall period. In some areas, particularly in forested lowlands, the fruits of rose (*Rosa acicularis*) and, to a lesser extent, highbush cranberries are taken fairly consistently in the latter portions of the fall season. Crowberry shows its greatest importance in late fall, but good patches of overwintered berries may receive heavy use in the spring.

Animal. Most vertebrate material reported here appeared to be carrion. Snowshoe hare (*Lepus americanus*), the most common item in this category, was found throughout both seasons but seemed to be slightly more important in the spring. Hind feet and pieces of hide are the most persistent remains of hare kills, and these were the *Lepus* parts involved in most occurrences. The only large volume of moose (*Alces alces*) meat found in this study contained hundreds of maggots, thus attesting to its carrion nature. Other moose occurrences were suspected carrion because of the nature of the material found (e.g., small pieces of hide and hair) in some cases and proximity of specimen collection points to known remains of moose killed by hunters in other cases.

The wing of a female goldeneye (*Bucephala* sp.), both wings and feet of a Varied Thrush (*Ixoreus naevius*), and pieces of fish skin all found in one stomach suggested that the bear involved had been cleaning up after a small carnivore or perhaps a raptor. A fledgling White-crowned Sparrow (*Zonotrichia leucophrys*) and two species of microtines found in my analyses were probably captured by the bears involved, but these were one-time occurrences.

Insects of the Order Hymenoptera constituted an important proportion of the animal food consumed. Adults, eggs, and pupae of ants (Formicidae) and wasps (Vespidae) occurred frequently, the former family being more important in the spring season and the latter in the early fall.

Other. Garbage, material discarded by human beings, was taken more often in the spring than it was in the fall. Bears which ate garbage usually ate large amounts. Debris refers to naturally occurring items that were obviously accidental or at least incidental. Pieces of rotten wood (which often occurred when ants were present), wasp nest material, and small stones were common debris items.

Discussion

Food Habits. The importance of green vegetation in the spring diet of black bears in interior Alaska is consistent with findings in other areas, though the specific plants involved differ from area to area. Horsetail, the predominant spring food in interior Alaska, was also important in northwestern Montana according to Tisch (1961), although grasses and umbellifers were more so. Chatelain (1950) found that "grass and grasslike plants" (including horsetails) composed the spring staple on Alaska's Kenai Peninsula. Except for grasses, other green plants in the interior Alaskan sample, such as wild rhubarb and lupine, were little used in other areas. Although roots and bulbs are popularly considered to be the favored spring bear foods, leafy material and young shoots appear to be the plant parts used most often in the interior of Alaska.

Animal food constitutes a relatively small portion of the black bear's total diet. In terms of frequency of occurrence, insects compose one of the most important animal foods as determined in this study and in the work of Tisch (1961), Chatelain (1950), Spencer (1955), Gilbert (1951) and others. A concentration of insects is apparently prerequisite to use of these organisms by bears as evidenced by the fact that colonial hymenopterans, especially ants, are the insects taken most consistently in all areas. Vespids, which were very abundant in 1964, were often eaten by bears during both years of this study. Entire nests were consumed in many cases and, obviously, the many hundreds of larvae packed into the combs of these formed an excellent source of concentrated animal protein.

Vertebrate animal food of bears, except for fish in some areas, is largely carrion. The high incidence of lagomorph carrion reported in this paper is apparently unique. Cottam, Nelson, and Clarke (1939) mention that "all" animal material found in their study was rabbit (Sylvilagus), but this involved only two occurrences. It was not known whether or not these were carrion. Cervid remains found in the interior Alaskan food habits analyses were almost certainly carrion.

Of fruits eaten by bears, Vaccinium appears to be one of the most important genera on the continent. Blueberries within the genus were by far the most important fall food in interior Alaska, were important on the Kenai Peninsula (Chatelain, 1950), were second only to acorns in early winter along the lower East Coast (Cottam et al., 1939), and ranked third behind apples and cherries in Maine (Spencer, 1955). Huckleberries within the genus were important to bears in northern Idaho (Rust, 1946) and were the most used berries in northwestern Montana (Tisch, 1961). Still within the genus, lowbush cranberries were commonly eaten in the spring and late fall in interior Alaska. These were also much used in the Kenai Peninsula according to Chatelain (1950).

But, even though Vaccinium is commonly used at lower latitudes, it seems to achieve its highest level of importance in northern regions. The many other fruits, including mast, which rival Vaccinium farther south (Tisch, 1961; Cottam et al., 1939; Bennett et al., 1943) are not available to Alaskan bears. Of the other fruits which are available in interior Alaska, some such as rose hips, highbush cranberries, and crowberries are important but are only occasionally so. Thus, the total picture in the interior during much of the fall period is one of consistent use of blueberries together with occasional use of a few other fruits. This compares with the Montana picture, presented by Tisch (1961), of consistent use of four or five fruits and occasional use of several others.

The opportunistic, omnivorous nature of the black bear has been stressed throughout the literature. This generally accurate characterization implies that simple food availability is one of the most important factors governing food habits and, indeed, the effects of availability have been obvious throughout this discussion. The use of green vegetation in the spring, of berries in the fall, and of animal material whenever possible are all functions of availability. But, within this broad pattern, other factors such as efficiency in meeting nutritional requirements and preference must be active for some available food items are used much more extensively than are others. In interior Alaska, the two plant genera, *Equisetum* and *Vaccinium*, were found to be such items. Evidence accumulated during this study plus recorded observations from past years suggest that interior Alaskan black bears are quite dependent upon blueberries. This hypothesis, as it may relate to the 1963 bear problems alluded to in the preface, is discussed in detail in the section dealing with bear-human interrelationships.

Appraisal of Food Habits Study Techniques. Since many of the bear food habits studies prior to this one have relied heavily upon scat analysis for data, one of my secondary objectives was to determine the utility and reliability of this technique. My experience in analyzing all three sample unit types (stomachs, intestines, and scats) plus the numerical results of these analyses will serve as the bases for my commentary on the subject.

There is no indication in the literature that analysis of intestinal contents has been used in bear food habits work before. This is understandable, as the intestinal tract is inconvenient to transport and store and is quite messy to work with. In addition, digestion in the duodenal region is almost impossible to stop. Even after prompt injections of formalin, the identity of many items in the first 2 m of the intestine will be lost in just a few hours. The intestinal analyses did yield some food habits data. However, their greatest contribution was the insight they provided into the results of transforming a "meal" to a scat. Some of these results as they apply to certain foods follow:

Green plant material appears to be little changed in either form or volume as it passes through a bear's digestive system.

Of the fruits important to bears in interior Alaska, blueberries appear to be the least durable in the digestive tract. Looking in the distal portions of the intestines, the proportion of intact berries in berry masses is generally smaller for blueberries than it will be for other species. Hence, blueberries probably show the greatest relative loss of volume in their passage through a bear. Many highbush cranberries and rose hips will also be collapsed or broken in transit, but since resistant material constitutes a fairly large proportion of the fruit of each of these species (large seed and tough skin in the former and many seeds in the latter), their integrity of volume is maintained fairly well. Lowbush cranberries and crowberries are quite durable throughout most of the berry season. However, after about mid-September both of these species become more like blueberries both in consistency and in reaction to digestion.

Of the main food categories, animal material appears to undergo the most drastic changes in a bear's digestive tract. Identity is seldom lost, as resistant materials (hair, claws, chitin, etc.) will usually be ingested with the meat of an animal meal. But, there are indications that quantitative changes may be fairly great. Of the 16 bears for which I obtained both stomach and intestines, 10 had one or more above-trace occurrences of animal material in their stomachs, yet only 1 contained animal material at greater than trace level in its intestines. At least part of this difference was attributable to the effects of digestion.

When insects occurred in stomachs, larvae and eggs (particularly of wasps) constituted a large proportion of the total insect volume. In intestines and scats, except for occasional collapsed skins, larvae and eggs were rarely evident although adults (probably preserved because of their greater chitin make-up) occurred frequently. Similarly, pieces of meat occurred with some of the vertebrate remains found in stomachs, but only hair, claws, and occasional bits of hide, bone and cartilage were found in intestines and scats.

Debris material was generally not affected by digestive processes. Wasp nest material proved to be an exception. After it had become moistened it appeared to lose considerable volume (probably through compression, although some of its components may have been soluble in the digestive fluids). Garbage materials usually remained identifiable as such throughout the digestive tract and, owing to a usually high incidence of undigestible items, rarely appeared to suffer volume changes.

In an actual comparison of my data, we see that the results of scat analyses (for the major food categories) are quite comparable to the results of my stomach analyses (Figures 2 and 3). Further, as an examination of Table 3 will show, there is agreement in order of magnitude between stomach data and scat data for many individual items. This is particularly true of some of the more important foods.

It should be evident that this comparison, on the basis of data differences (or similarities), is subject to interpretive error. Differences may be real due to actual differences in food habits between bears contributing to the stomach samples and those contributing to the scat samples, or they may be apparent due to errors in one technique or the other. In the same manner, similarities may be real or they may be coincidental due to error. In this case, I prefer to assume that most of the similarities in my data are real, not just coincidental. (Field observations tend to support the laboratory data.) It may sound as though, in making this assumption, I am saying that one technique is no better than the other. In reality, as I shall soon point out, the answer to this lies in the application of a particular study.

Since few items lose their identity during digestion, it is my conviction that frequency of occurrence data from scat analysis is very nearly as good as that from stomach analysis. We might expect, from what was mentioned earlier, that animal material would be better represented in the stomachs. Indeed, Table 3 meets this expectation in showing that a greater variety of animals was found in stomachs than in scats, although the rare, one-time-occurrence items constitute the difference. Among the animals that appeared to be fairly consistently eaten, frequency data for stomachs and scats are similar. (As Table 4 will show, this does not imply that minor items do not show up in scat data.)

With respect to volume, we should certainly expect an under-representation of animal material in scats. This does not show up in my data, perhaps partly because my method of estimating a volume category in scat analysis may serve to automatically cancel the diminishing effects of digestion. Recall that during the intestine studies, blueberries were also found to diminish in volume during passage through the digestive tract. Despite this fact, these berries are usually taken in large quantities and there is little danger of their being greatly under-represented.

In conclusion, I feel that a good collection of scats can justifiably serve as a base for nearly any bear food habits study. If a study is oriented toward determination of basic food habits patterns, scats alone may be adequate. If emphasis is to be placed upon the animal food of the bears concerned, a series of stomachs will also be needed both to insure that reliable quantitative data are obtained and to insure that the data are properly interpreted. (If I had used only scats in my study, I could have said nothing about the incidence of *Lepus* in my findings. However, noting the nature of *Lepus* occurrences in the stomachs, I was able to state fairly confidently that most represented carrion.)

A final consideration in the comparison of scat analysis and stomach analysis is the time and effort involved in each. It was my experience that scats are far easier to obtain, transport and store than are stomachs.

Further, it took an average of about one half hour to analyze a scat whereas 6 to 8 hours were required for the analysis of each stomach.

PHYSICAL CHARACTERISTICS

Color

Of 86 bears reported seen or shot in the study area in 1964, only 5 (5.8 percent) were of the cinnamon or brown color phase. In 1965, 13 of 163 bears (8.0 percent) were cinnamon. The overall average incidence of the brown phase in this Alaskan study is 7.2 percent, a figure considerably lower than the 51 percent (of 469 bears) recorded by Skinner (1925) for Yellowstone Park. Within the study area, the cinnamon phase seems to be more abundant to the east than to the west. Karl Schneider (pers. comm.) reports that brown black bears are common in the Tetlin area, while many residents of Tanana and Manley Hot Springs whom I interviewed appeared to be unaware that brown black bears exist. I do not know to what extent confusion with grizzly bears has contributed to the impression that brown phase black bears are rare in this latter, more western part of the study area.

Actual colors of the brown phase bears seen during this study have been quite variable. The most common color seems to be a rich chocolate brown, though at least two bears were reddish-brown, two more were beautiful honeyblondes with auburn markings, and another was a light buff-brown.

Of the 18 cinnamon bears in my sample, the sex of 6 is known and these were all males.

In his description of the black bear, Erickson (1965) says that a small, white chest patch is usually present. This seems to be true of most bears in the "lower 48" states, but the chest patch rarely occurs on interior Alaskan black bears. I have never seen it in the course of examining over 100 hides, and Frank Entsminger, a Fairbanks taxidermist who has handled many bears, reports that he has seen it only once in Alaska although he remembers it as being common in Montana.

Size

It is my belief that the great weights (over 400 pounds) documented for many bears in the continental United States and for some bears in coastal Alaska are attained exceedingly rarely by interior Alaskan bears. My data, though too scanty to be taken as conclusive evidence, support this belief.

Table 5 lists actual total weights of five bears and estimated total weights extrapolated from skinned and dressed weights of nine other bears. The "size" classifi-

Table 5. Actual or extrapolated[a] total weights of 14 interior Alaskan black bears.

MALES

Specimen No.	Age[b]	Season[c]	Size	Wt. lbs.	Wt. kg
2	Y	S	small	61*	27.7
122	Y	S	small	64*	29.1
112	A(?)	S	medium	129*	58.6
105	A	S	medium**	206	93.6
5	A	S	med-large	230	104.5
11	A	F	large	257*	116.8
114	A	S	large	290*	131.8
Mean (with yearlings)				176.7	80.3
Mean (without yearlings)				222.4	101.1

FEMALES

Specimen No.	Age	Season	Size	Wt. lbs.	Wt. kg
110	A	S	small**	96*	43.6
118	A	S	small**	120	54.5
126	A	F	small**	127	57.7
10	A	F	medium	159*	72.3
7	A	F	small**	173*	78.6
8	A	F	medium	207*	94.1
9	A	F	medium	240	109.1
Mean (no yearlings)				160.3	72.9

[a]Patrick (1961) gives an equation for estimating total weights of Ontario black bears from the weights of skinned and dressed animals. Lacking sufficient data to derive my own equation, I have used his although I suspect that his specimens were all taken in the spring (he does not say). Of my five known-weight bears, four were spring animals (actual weights in lbs.-206, 230, 120, 127). Their estimated total weights using Patrick's equation are 2.9 percent low, 4.8 percent low, exactly equal, and 2.4 percent high respectively. The estimate for my known-weight fall specimen (a fat animal with an actual weight of 240 lbs.) is 19.9 percent low.

[b]Age: Y=yearling; A=adult.

[c]Season: S=spring; F=fall.

*Extrapolated weights.

**Size classification made by the investigator. (Others were made by the hunters.)

cation is based most often upon the hunter's evaluation of his animal although a few animals, as indicated, were classified by the investigator. Note that both of the "large" males weighed under 300 pounds. The smaller of the two was originally estimated by the hunter to weigh "at least 350 pounds." Throughout the study, this has been the trend, i.e., people have usually over-estimated the weight of bears by 20 to 30 percent.

During this study, skull measurements and harvest information were obtained for six bears which were estimated by the hunters to weigh 400 to 450 pounds. These bears, all males, were obviously large--four of them qualified in the Boone and Crockett record class, and the other two were short by just a few sixteenths of an inch. Five of these animals were taken in the early spring, a time when total body weight is likely to be near the annual minimum.

All in all, the observed trends in weight estimation and the actual weights obtained during this study leave the above reported weights in some doubt. In reality, the interior Alaskan bear that attains a weight of 400 pounds is probably an exceptional animal. Further, it would probably be an animal weighed in the late fall.

With respect to weights of female bears, the extremes obtained in this study, 96 pounds and 240 pounds, fall within the range of weights given by Erickson, Nellor, and Petrides (1964) for 25 sexually mature female bears in Michigan. The mean of 160.3 pounds for my seven bear sample compares with 185 pounds for the 25 bears weighed by Erickson et al. (1964) and 189 pounds for 12 sexually mature female bears from Florida (Harlow, 1962).

Size of Skull

A consideration of skull size is important as it relates to the potential of the interior Alaskan black bear as a trophy animal. Harlow (1962) says that in a comparison of skulls (both sexes) from Florida, Virginia, and Alaska, the Alaskan skulls were the smallest. He does not mention either the magnitude of the differences or the size of his samples. Of 164 record class bears listed by the Boone and Crockett Club (1964), 22 are from Alaska and only two are from the interior. Of these last two bears, one is a male from the Kantishna River area which measured 20 12/16 inches (sum of greatest length and greatest width of skull) and ranked 49th. The other, the only one within my study area, ranked 151st with a measurement of 19 4/16 inches. Though these measurements are well below the 21 15/16 inch world record from Wisconsin, the conclusion that Alaskan bear skulls are indeed smaller than skulls from other areas does not necessarily follow. Three coastal Alaskan bears have scored higher than 21 inches.

Lack of trophy hunting pressure has probably been the factor contributing most to the lack of record class (minimum score 20 inches up until 1963 and 19 inches since then) bears from the interior. Most bear kills are random and the necessary combination of a hunter interested in recording trophies meeting a really large (over 20 inches) bear has not yet occurred.

Most interior Alaskan bear habitat does not lend itself to typical trophy hunting, i.e., looking at several animals and shooting the best of these. Bears are usually well dispersed and most stay in or near the cover of forest vegetation. Of the record class bears handled during this study (Table 6), two of these, numbers 102 and 104, were taken within two days of each other in the lake-dotted lowlands of Minto Flats. Another animal, taken by the same group of hunters, fell just short of 19 inches. All three of these animals were first spotted from the air, then shot by hunters brought to the ground by aircraft on floats. This is one of the few situations, in interior Alaska, in which a number of bears may be both observable and accessible. Even in this situation, however, the distance of a potential trophy from a body of water suitable for landing often precludes a kill.

Table 6. Trophy bears from interior Alaska, 1963-1965.

Specimen No.	Location of Kill	Date of Kill	Sex	Boone & Crockett Score
113	Murphy Dome	6 June 1965	Male	19-2/16
none	Badger Road	? Aug. 1963	Male	19-5/16
102	Minto Flats	20 May 1965	Male	19-5/16
104	Minto Flats	22 May 1965	Male	19-6/16
4	near Clear*	3 July 1964	Male	19-8/16
none	Birch Creek	1963	Male	19-15/16

*Clear Air Force Station

SEASONAL ACTIVITIES

On 1 May 1965, an aerial observer reported seeing three single bears feeding in marshy areas along the Tanana River between Fairbanks and Nenana. These observations constituted the first reported bear sightings of the year. The last 1965 observation came on 2 October when another pilot reported seeing a sow with three cubs on a snow-covered ridge east of the Minto Flats. Using these two dates, the 1965 bear season was at least 154 days long. No date for earliest 1964 spring appearance is available, but the last reported sighting in that year was on 4 October. From these data and from interviews with a number of experienced outdoorsmen, it appears that the activity season for a black bear in interior Alaska is usually five to five and one-half months in duration beginning in early May and ending in early to mid-October. It follows that six and one-half to seven months of the year is spent in the winter den.

The spatial distribution of bears seems to be governed largely by food availability. The animals appear to be most wide-ranging throughout May and June and into July as they make use of carrion and berries left over from winter as well as new green vegetation. And it is during this time that garbage dumps, campground trash cans, and human habitations are most likely to receive bear visits. As shown in Table 7, interior Alaskan bears are observed most often in river bottom, lake shore, and other lowland situations throughout this spring period.

During the beginning of the fall season (late July-early August), most local bear populations apparently engage in major movements to alpine areas. This movement is reflected in the distribution of observations at that time as shown in Table 7 and is presumably in response to the ripening of berries in the high country. Mr. J. Berdohl, who shoots at least one "nuisance" bear each year at the Circle Hot Springs Lodge (of which he is proprietor), told me (pers. comm.) that his bear worries cease when the blueberries ripen. My own observations substantiate this. Throughout the first half of the 1965 field season, bear activity was obvious in the Deadwood Creek-Central-Circle Hot Springs area (refer to Figure 5). Tracks and droppings were common along the roads, in the deciduous forested areas, and especially around garbage disposal sites. In a few instances bears, themselves, were seen. During this same period, I made several trips into the upper Deadwood

Table 7. Distribution of observations (interior Alaskan black bears) by half-months in 1965.

		Lowlands		Uplands		Unknown	
	Time Period	No. Obs.[a]	No. Bears[b]	No. Obs.	No. Bears	No. Obs.	No. Bears
SPRING	1-15 May	14	18	0	0	1	1
	16-31 May	21	24	2	5	0	0
	1-15 June	3	5	1	1	0	0
	16-30 June	4	4	0	0	0	0
	1-15 July	5	8	0	0	0	0
FALL	16-31 July	5	9	3	5	0	0
	1-15 Aug.	2	2	6	14	0	0
	16-31 Aug.	0	0	0	0	0	0
	1-15 Sept.	0	0	0	0	1	1
	16-30 Sept.	2	5	5	7	0	0

[a]Number of observations of bears.

[b]Total number of bears involved in the observations.

Creek-Switch Creek area 6 to 10 miles distant to establish berry production plots there. Bear sign was virtually absent from this alpine area.

The first reported 1965 sighting in the alpine country was made on 18 July by Mr. and Mrs. J. W. Parker at Switch Creek. On 29 July I watched a bear as it moved up the upper Deadwood Road toward high country. By mid-August bear sign could be found in ridge-top and timberline situations but was conspicuously lacking in the neighboring lowlands. Fresh garbage in the Central and Circle Hot Springs dumps was untouched, and trash barrels at Ketchem Creek Campground remained upright. It was at this time that Berdohl related to me his belief that, as usual, blueberries had drawn the animals to higher areas.

On 21 July 1965, I returned to the Deadwood area after a 20 day absence and found that blueberries had begun to ripen. According to my field notes, there were many ripe berries in the lower areas along the Circle Hot Springs Road and a few at creek bottom level near Switch Creek. Recall that the first 1965 bear sighting, made by Parkers at Switch Creek, had occurred only three days earlier. Berries on the ridges above Switch Creek were still green on 23 July, although by 28 July high country berries in a few south-facing situations were beginning to show signs of ripening. It should be recalled that the following day, 29 July, was the date of the second bear sighting in the area. The berry productivity plots established earlier in the year were sampled from 11 August to 18 August. It was noted during this time that ripe blueberries could be found at all elevations, although the proportion of unripe to ripe berries seemed to be greatest at the highest elevations. It was at this time that the disappearance of bears from the lowlands and appearance of sign in high country became obvious.

Since blueberries can be found at all elevations in many areas, I do not know exactly why most bears choose to move into alpine areas for them. It is probable that the berries are generally more abundant in the higher areas where competing and shadow-casting plants are fewer. Or, it may be that the alpine berries are qualitatively superior; some human berry-pickers I have communicated with are of the opinion that "berries found above timberline are the sweetest." It should also be mentioned that a bear scat, believed to be about a week old when found near Circle Hot Springs on 22 July, consisted almost entirely of unripe blueberries. Other early fall scats contained fair numbers of green berries. This indicates that the completely ripe condition of the berries is not prerequisite to their use by bears, hence it is probably not the factor which sets off the altitudinal "migration." Yet, it seems clear that both utilization and movement begin with the later stages of berry development.

My ground observations of the uphill bear movement in the Deadwood area is supplemented by the aerial observations of Dr. Eugene Evonuk, physiologist with the Arctic Aeromedical Laboratory, who made routine flights to his cabin in the Minto Flats throughout the summer of 1965. His observations, listed in Table 8, show a definite relocation of bears from the Flats to neighboring ridges in late July. The bear of observation no. 10, the only one listed as seen in low country after the 17th of July, was a large male which had been raiding cabins there, and which was shot by Dr. Evonuk. According to Evonuk (pers. comm.), the bears seen in the alpine situations were feeding on blueberries. In his experience, and in the experience of a number of other interviewees, this is an annual fall occurrence.

Bears continue to use blueberries for as long as the latter are available. Due to the effects of the night frosts which are common in September, berries soften and drop from the bushes until, by mid-September, few remain. From then until the denning period, bears fill in with whatever else is available. In areas accessible to humans,

Table 8. Aerial observations of black bears in the Minto Flats area during the summer of 1965.*

Obs. No.	Date	Bears Seen	Location
1	3 June	1 adult	Between Tolovana R. and Minto Lake.
2	3 June	sow w/ 1 cub	Minto Flats, north of Minto Village.
3	10 June	1 adult	Upper Tolovana R., Minto Flats.
4	11 June	sow w/ 2 cubs	Near Big Minto Lake.
5	11 June	1 adult	One mile east of Big Minto Lake.
6	17 July	1 adult	Two miles south of Big Minto Lake.
7	24 July	sow w/ 2 cubs	East of Minto Lakes, working up ridge.
8	1 Aug.	sow w/ 3 cubs	East of Minto Lakes, high on ridge.
9	1 Aug.	1 adult	Saddle on ridge southwest of Murphy Dome.
10	7 Aug.	1 adult	One-half mile south of Minto Lakes.
11	8 Aug.	sow w/ 2 cubs	Ridge east of Minto Lakes.
12	8 Aug.	sow w/ 1 cub	Ridge east of Minto Lakes.
13	8 Aug.	sow w/ 1 cub	Ridge east of Minto Lakes.
14	8 Aug.	2 adults	Other side of ridge east of Minto Lakes.

*Only those observations recorded by Dr. Eugene Evonuk are listed in this table.

remains of game kills provide a source of animal food at this time. But, most of the food consumed after the blueberry season consists of fruits which have been largely ignored until this time, particularly lowbush cranberries, and to some extent crowberries, highbush cranberries, and bearberries. During the last week of September and first week of October in 1964, tracks were common and a few cranberry-laden scats were found in the deciduous-forested flats across the Tanana River from Fairbanks. At the same time, lowbush and highbush cranberries dominated in scats picked up in the Bonanza Creek Forest along the Nenana Highway. Thus, though most of these other berries are available in alpine situations, there are indications that many bears move back down into forested areas for them in the late fall. Evonuk (pers. comm.) has indicated that, on the basis of his observations, bears do seem to move downhill after the blueberry season, then move back up into the high country to den.

Little has been learned in this study with respect to denning. Although it is probable that many dens are located in the better drained, rocky, alpine areas, all the den sites reported during this study were at lower elevations. Two dens were found after they had been vacated.

One was located fairly low, roughly 200-250 m in elevation, on an aspen-forested, south-facing slope just a few km north of College, Alaska. According to its discoverer, Dr. R. B. Weeden (pers. comm.), this den was located in the side of a small, dry wash. It consisted simply of an entrance hole about 65 cm in diameter leading into a main chamber which extended 1.5 to 2.0 m into the silty substrate. A small hole of undetermined length extending from this main chamber suggests that the bear had simply enlarged the first couple meters of the den of another mammal, probably a fox (*Vulpes fulva*). The second vacated den, described by K. Schneider (pers. comm.) was found in the Tetlin Lake area. It consisted of a hollow among the roots of a tree blowdown and, like the den described above, appeared to have been excavated by the bear occupant.

In early April of 1965, T. Brady (pers. comm.) visited a supposedly traditional bear denning grounds near C.O.D. Lake in northern Minto Flats (see Figure 4). This denning area, consisting of a series of low, limestone cliffs and ridges about 2.5 km long, is said by natives to have been the scene of annual spring bear hunts thirty or forty years ago. Potential den caves and hollows proved to be abundant, and Brady reported that bear tracks, though possibly all from the same bear, could be found in the snow at the entrances of several of these. Only one denning bear was seen.

On 17 October 1965, after observations of bears and bear sign had ceased, Alaska Cooperative Wildlife Research Unit Leader, Dr. David R. Klein, and I visited this denning area. During the course of the day, all potential den sites that were seen were explored. Though evidence of past use by bears was present at some of these sites, no bears were seen and there was no indication that any bears were in the area at that time.

REPRODUCTION AND PRODUCTIVITY

Reproductive organs collected during this study were not examined, but were saved for future work. Reproduction in the black bear has been studied in some detail by Erickson et al. (1964), and the general patterns for south-central Alaskan bears has been worked out by Rausch (1961).

It would be difficult to establish a sex ratio for the black bears in interior Alaska on the basis of kill data, particularly under the present game laws. With the three-bear limit and no kill report required, there is a tendency for only the larger kills, hence the males, to be made known. Further, male bears seem to be involved in "nuisance" situations more often than do females (Erickson et al., 1964; my own observations), and this adds to the effect of an apparent preponderance of males. For the two years during which this study was made, there is record of 57 bear kills for which sex is known. Of these, 39 (66.7 percent) were males. Most of the 57 kills (41) were reported in 1965 after I had enlisted the aid of a local taxidermy shop. In 1964 reports of many of the 16 kills represented came more or less randomly as I chanced upon them. The sex ratio of these was nine males to seven females.

Most, if not all, of the published information on black bear litter sizes is based on observations made after emergence of the litters from the winter dens. Matson (1951) feels that such summer observations have led to the supposition that fewer cubs are born than is actually the case. He explains that there is plenty of time for cub mortality during the two month period (eastern United States) between parturition and emergence from the dens. In interior Alaska, where this period is at least twice as long, the situation is probably magnified. The number of young that can be nourished for approximately one-third year by a fasting female animal must be limited!

With respect to litter sizes after emergence from dens, "two or three cubs" is the "normal" given most often in the literature. Matson (1951) indicates that quadruplets and quintuplets, though not common, are reported fairly often. Rowan (1947) has record of sextuplets. I have two somewhat questionable observations of four-cub litters from interior Alaska. The first, questionable because it was received third-hand, supposedly occurred near Livengood during August of 1963. The second involved a capture by Arctic Aeromedical Laboratory personnel of three cubs south of Fairbanks in May of 1965, followed the next day by a sighting of a sow with a cub in the same area. The sow was said to have been recognized as the mother of the three cubs captured, thus it was deduced that she had had four. No interior Alaskan with whom I communicated claimed hearing of litters larger than four.

Table 9 lists litter observations reported during the two years of this study. The 1965 "four-cub litter" mentioned above is listed as a known three-cub litter because of the doubt involved. The mean litter sizes given for the two years can be compared with 1.96 for 23 south-central Alaskan litters and 2.15 for 20 Michigan litters as given by Erickson et al. (1964).

The apparent low productivity, or at least low cub survival, in 1964 did not come as a surprise. As will be discussed in another section of this paper (see Bear-Human Interrelationships) the fall of 1963 was characterized by relatively low blueberry production in many parts of the interior. No doubt related to this was the fairly high incidence of reports of late-season bears in poor condition, i.e., not fat. It was felt that many bears went into hibernation in much leaner condition than they ordinarily would have. In addition, the spring of 1964 came very late in interior Alaska. As indicated by Schneider (1965) waterfowl nesting near Tetlin, a village

Table 9. Black bear litter sizes in interior Alaska, 1964-65.*

	Total Litters		One-cub Litters		Two-cub Litters		Three-cub Litters		Cubs Per Litter
Year	No.	Per-cent	No.	Per-cent	No.	Per-cent	No.	Per-cent	Mean
1964	10	100	5	50	5	50	0	0	1.50
1965	20	100	6	30	11	55	3	15	1.85
	30	100	11	37	16	53	3	10	1.73

*All of the 1964 litter sizes were obtained through observations. None of the 7 female bears taken by hunters in that year was accompanied by cubs when it was shot. In 1965, 3 of 10 hunter-killed female bears were accompanied by litters and these are included with 17 observed litters to form the 1965 data.

on the southeast border of the main area considered here, was set back about two weeks. Other phenological phenomena, including green plant growth and emergence of bears from dens, were possibly retarded even more. This combination of a lean fall plus a prolonged denning period would likely have been conducive to both low production and low survival of cubs. The conclusions relative to the 1964 data presented in Table 9 are self-evident. It should be mentioned that there were not even rumors of litters larger than two during that year.

There was no notable lack of foods in the fall of 1964 and spring of 1965 arrived "on time," thus the 1965 litter data are probably more nearly normal. That year three-cub litters were seen and, as mentioned above, there is a possibility that one litter consisted of quadruplets.

Overall, it appears that most litters brought from the dens in interior Alaska consist of one or two cubs. The actual mean litter size is probably higher than the 1.73 indicated in Table 9, as this figure suffers from the influence of the extreme 1964 conditions. At the same time, if one-cub and two-cub litters are the most common, the overall mean is almost certainly lower than 2.00. Finally, the evidence suggests that the condition of the female at the beginning of the denning period and the duration of the denning period are two important factors governing the size of the litters that actually emerge from the den.

POPULATION DENSITY

During an evening flight on 19 May 1965, I observed six different black bears in the Minto Flats area. The first three animals, seen fairly early (before 8:45 PM) were lying down in small stands of deciduous timber on "islands" of dry ground. The others, seen later, were moving or had moved out into the open marshes to feed. From this experience, it appeared that it would be feasible to obtain some black bear population density information for the Minto area by flying transect lines. On 26 May a Cessna 180 aircraft was used to fly five east-west transect lines, (shown on Figure 4) covering a total linear distance of 103 miles in the northern half of the Flats. The two observers, Dr. F. C. Dean on the right and the investigator on the left, limited observations to the area within one-fourth mile on each side of the plane, thus making the effective strip covered one-half mile in width. The resulting effective area covered was 51.5 square miles (134 km^2).

Results obtained on these transects were almost certainly minimal. During the week between the initial flight and the census flight, foliage had appeared on the deciduous trees and visibility was limited to the open areas.

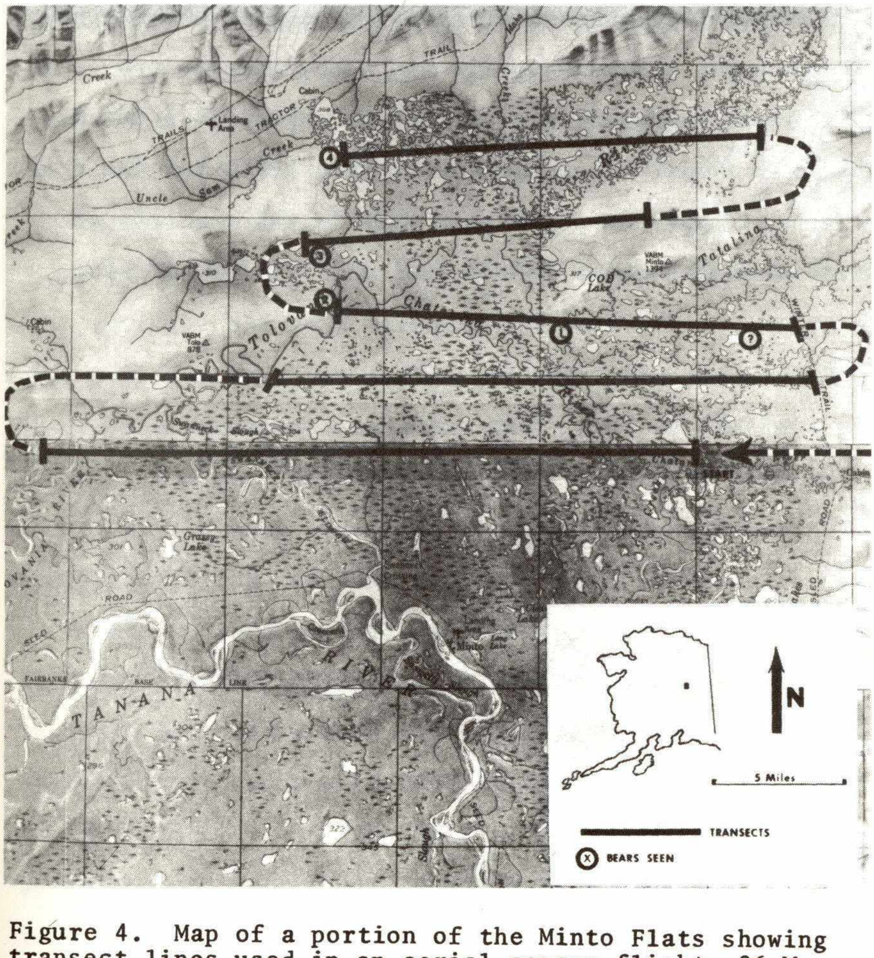


Figure 4. Map of a portion of the Minto Flats showing transect lines used in an aerial census flight, 26 May, 1965.

Transects were begun at 8:20 PM, when most bears were probably still lying down in the hardwood stands as they had been the previous week. The first positive sighting was not made until after 9:00 PM. This bear had just moved out into the open from a hardwood stand. There were four positive sightings, all of bears in the open, and one probable, but unconfirmed, sighting of an animal in a deciduous stand. Thus, figuring four or five bears for the area covered, the apparent population density was one bear for each 10-13 square miles (27-33 km^2) of this lowland area.

PARASITES

The only parasites encountered during this study were intestinal helminths discovered incidental to the food habits work. Table 10 lists the occurrences together with quantitative data for the 16 intestinal tracts examined. A total of 12 of the 16 bears represented (75 percent) had intestinal parasites. Only cestodes occurred in three bears (19 percent), only nematodes occurred in five bears (31 percent), and both cestodes and nematodes occurred in the remaining four bears (25 percent). The smallest infestations occurred during the early part of the bear season. Rausch (1961) implies that this is an expected phenomenon because parasites feeding on chyme could not be supported during the long winter fasting period.

All cestode scoleces examined proved to be cyclophyllideans, probably _Taenia_ spp. Rausch (1961) has experimentally infected a bear with _Taenia_, but the only cestode reported taken from wild southcentral Alaskan black bears is _Diphyllobothrium_. The lack of such pseudophyllideans in my sample could probably be taken as further evidence of the lack of fish in the diet of bears in interior Alaska.

Table 10. Intestinal parasites from 16 interior Alaskan black bears.

Specimen No.	Date Taken	Parasites Present	Number	Vol. (cc)	Wt. (g)
2	28 June '64	nematodes	4		
3	8 July '64	none			
105	26 May '65	none			
109	31 May '65	none			
110	31 May '65	cestodes	1-2		
112	5 June '65	none			
114	9 June '65	nematodes	1		
		cestodes	?	19	13.8
118	25 June '65	cestodes	?	78	40.4*
126	30 July '65	cestodes	?	125	72.0*
7	24 Aug. '64	nematodes	13	1	
		cestodes	?	8	
8	25 Aug. '64	nematodes	18	11	11.3
		cestodes	?	62	63.0
9	27 Aug. '64	nematodes	29	8	7.6*
10	4 Sept. '64	nematodes	4		
		cestodes	?		
12	12 Sept. '64	nematodes	249	101	106.8
13	12 Sept. '64	nematodes	53	57	56.9
131	17 Sept. '64	nematodes	1		

*Somewhat desiccated, perhaps from the initial preservative (10 percent formalin).

Most, and perhaps all, of the nematodes found were members of the family Ascaridae, which Rausch (1961) says are common particularly in the late summer and early fall. Since King, Black, and Hewitt (1960) considered an infestation of 39 ascarids in one bear to be worthy of special mention, attention should probably be called to the infestations listed in Table 10 for specimens 12 and 13. Many of the worms in both of these bears were 15-18 cm long. Regarding these two infestations, it is also noteworthy that each of the bears involved was a young male weighing approximately 125 pounds (57 kg), and each was shot on Ester Dome (about 10 miles west of Fairbanks) on 12 September 1964.

BERRY PRODUCTION AND UTILIZATION

Productivity Sampling Study

Introduction. There is some indication that fruit, shown by food habits analyses to be the most important item in the interior Alaskan black bear's fall diet, may constitute the main food with which the animal builds up the fat reserve that will sustain him through the winter. In addition, movements and activities of bears in the fall, condition of the animals prior to denning, production and survival of cubs, availability of bears to hunters, and perhaps even individual bear temperament all seem to be related to the abundance and perhaps the quality of certain berries. During the 1965 field season, an attempt was made to measure productivity of blueberries, cranberries, and crowberries, the three berry species which food habits studies and observations had indicated were probably the most important to bears in interior Alaska.

All berry sampling was done within the drainages of Deadwood Creek and Switch Creek near Circle Hot Springs, Alaska. Though encompassing a relatively small area, this drainage supports a variety of the berry-producing vegetation types described in the study area section, including deciduous forest on most of the southern exposures and dry creek bottom areas, open black spruce forest and muskeg on north slopes and poorly drained areas, and a fairly recent burn area which apparently passed through both deciduous and coniferous types. The ridges, most of which occur at about 750-900 m, are mostly dry, rocky alpine tundra flanking a few moist tundra saddles. For the purposes of this study, 11 sample plots were chosen within each of three habitat types:

Spruce Forest - includes all situations in which black spruce was the most abundant tree in the immediate vicinity. Five of these plots occurred in muskeg, and the other six were on drier sites.

Deciduous Forest - includes all situations in which non-coniferous trees and large shrubs were the most abundant woody plants. Six of these plots were in valley-bottom aspen forest, and the other five occurred low on slopes with some southern exposure. All were dry sites.

Tundra - includes all situations in which tree-form vegetation was scarce or lacking. Six of the tundra plots occurred in moist, alpine saddles while the other five were established below timberline on treeless or nearly treeless expanses of muskeg.

Procedure. Within a given habitat type, the only requirement that a piece of ground had to fill in order to be chosen as a plot was that it be fairly homogeneously covered with plants of at least one of the three berry species concerned. Each sample plot, a square measuring 5 m on each side, was subdivided into 25 subplots of 1 m^2 each (numbered 00 to 24). Each plot was oriented so that subplot 00 was in the southeast corner. Each subplot was further subdivided into quarters by its diagonals.

To eliminate bias in choosing berry patches, all sample plots were established in June and early July before the appearance of berries. Establishing a plot consisted of marking each corner with a wooden stake approximately 1 m high and tying colored surveyors' tape nearby where it would be most conspicuous. It was originally hoped that 10 plots could be sampled in each habitat type, thus one extra plot (making a total of 11) was established in each to allow for possible loss or destruction of one of them. No loss was experienced and all 33 plots established were sampled. The location of each of these within the Deadwood Creek study area is shown in Figure 5.

All sampling was accomplished during the seven-day period from 12 August to 18 August, at which time most blueberries appeared to be ripe. Prior to sampling, five subplots were chosen from each plot by use of a random

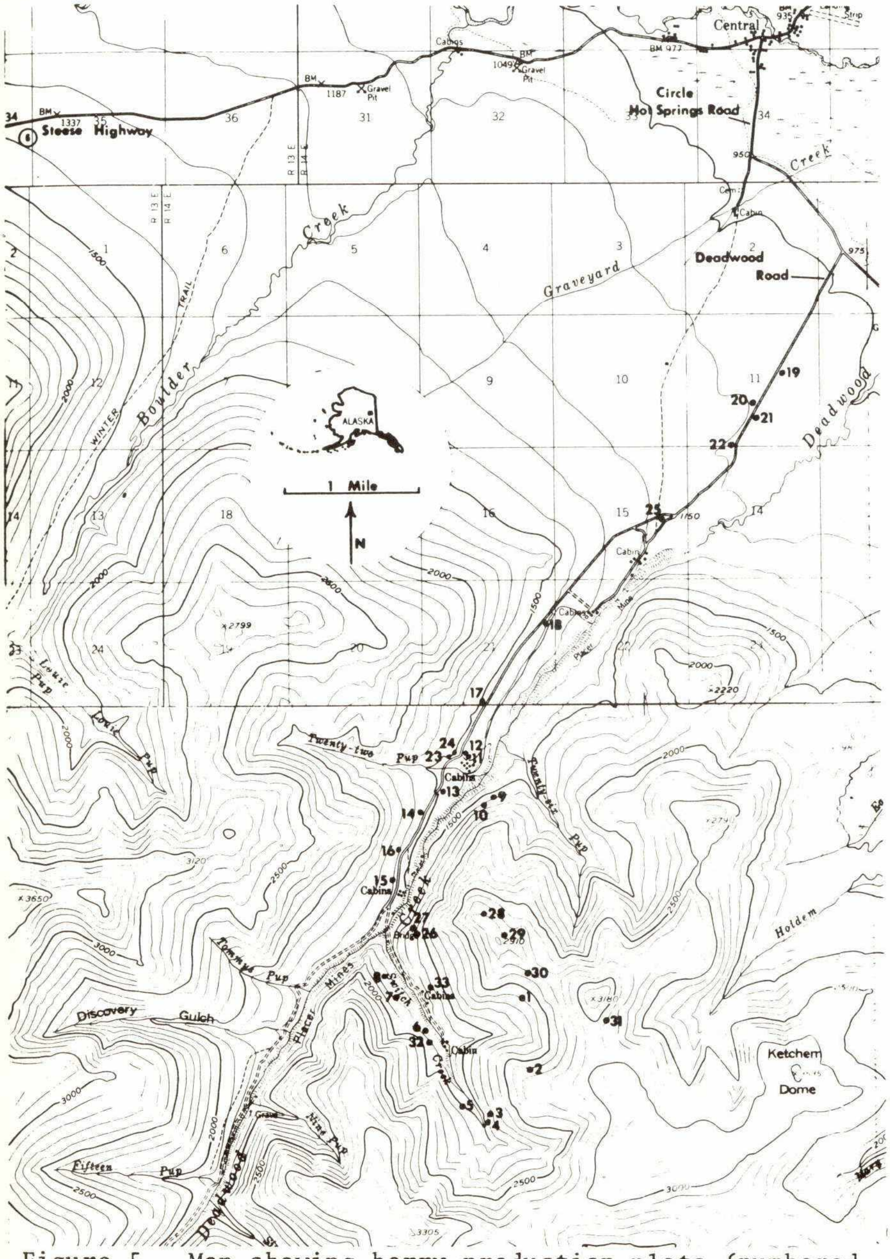


Figure 5. Map showing berry production plots (numbered 1-33) in the Deadwood Creek-Switch Creek area, interior Alaska.

numbers table. Two quarters within each subplot (also chosen randomly) were then picked clean of berries. Numbers of berries of the various species in each quarter and total weights of each species taken from the plot were recorded.

Results and Discussion. Upon examination of the data presented in Table 11, one can see that the ranges of values, hence the associated variances, are very high for this small sample and any confidence limits calculated would undoubtedly be so wide as to be meaningless. For this reason, no attempt has been made to treat the data statistically. Rather, results will be discussed in general terms, and apparent trends will be pointed out.

As depicted in Figure 6, deciduous forest was the most productive habitat. This was due largely to the excellent cranberry crops that occurred on several plots in the aspen forests along lower Deadwood Creek. Production on tundra in this region was low. This probably resulted from the effects of two violent hailstorms which, occurring while blueberry plants were still in bloom (27 and 28 June), knocked most of the flowers from the plants. The more protected areas within open spruce and muskeg areas produced the best blueberry crops of the three

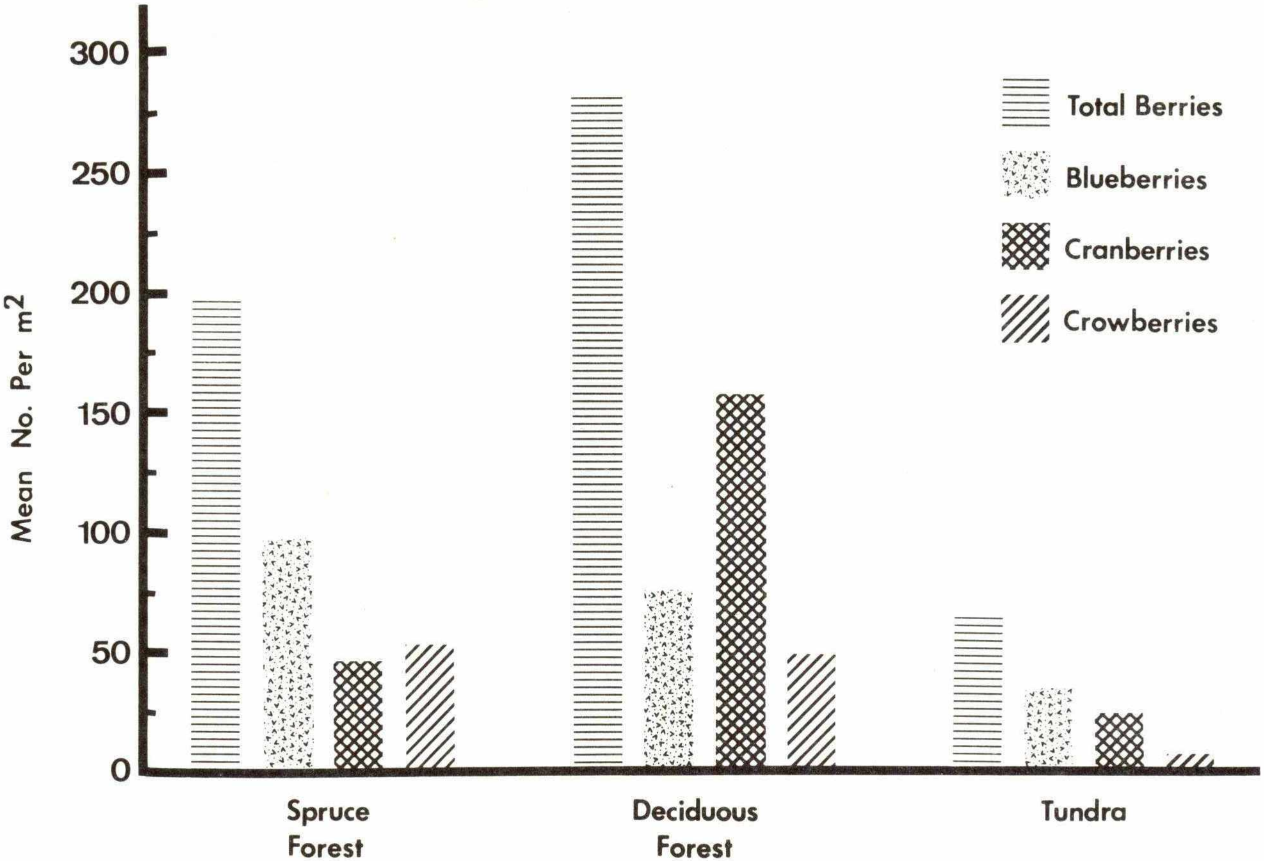
Table 11. Berry production (numbers per m^2 and weights, in grams, per 100 berries) in each of three habitat types at Deadwood Creek, Alaska, 1965.

	Plot	Blueberry		Cranberry		Crowberry		Total
	No.	No.	wt/100	No.	wt/100	No.	wt/100	No.
SPRUCE FOREST	1	107	30.2	1	10.0			108
	2	67	19.2	15	17.0			82
	9	39	23.4	18	13.2			57
	10	36	18.8	4	11.8			40
	11	250	34.2	17	18.8	110	24.4	377
	12	150	35.6	24	17.5			174
	13	4	32.2	190	14.3			194
	14	93	32.5	193	17.4			286
	17	21	21.3	1		14	14.7	36
	18			13	21.9	109	18.4	122
	23	293	36.7	41	16.4	342	23.3	676
	Total	1,060		517		575		2,152
	Mean	96.4	28.4	47.0	15.8	52.3	20.2	195.6
DECID. FOREST	3	210	33.5	2	10.0			212
	4	577	32.5	7	15.0			584
	15			4	11.8			4
	16			10	17.2	28	15.7	38
	19			1				1
	20			252	22.1	30	29.9	282
	21			256	13.1	282	21.2	538
	22	7	27.2	558	17.0			565
	24			57	18.0	189	16.1	246
	25			486	19.8			486
	33	27	20.1	93	14.3			120
	Total	821		1,726		529		3,076
	Mean	74.6	29.6	156.9	15.8	48.1	20.7	279.5

Table 11. (Continued)

	Plot	Blueberry		Cranberry		Crowberry		Total
	No.	No.	wt/100	No.	wt/100	No.	wt/100	No.
	5	58	27.9	108	13.4			164
	6	104	37.6	66	14.4			170
	7	44	26.1	24	12.3			68
	8	7	24.4	4	16.0	3	11.4	14
	26	10	15.0	2	14.0	1		13
TUNDRA	27	62	18.4	1				63
	28	2	24.0					2
	29	1				1		2
	30	1						1
	31	20	20.8	32	10.2	8	20.0	60
	32	72	36.1	19	19.2	46	12.9	137
	Total	381		256		59		694
	Mean	34.6	25.6	23.3	14.2	5.4	14.8	63.1

Figure 6. Berry production (numbers per m^2) in each of three habitat types at Deadwood Creek, Alaska, 1965.



habitat types in this area. Throughout the interior, blueberry crops for 1965 were classified by most observers as excellent. Along the Elliott Highway, Chena Hot Springs Road, and in other areas of the interior, some of the best blueberry patches occurred in alpine situations where it is believed hailstorms did not occur during the critical bloom period.

Certain plots within each habitat type are worthy of discussion. With respect to blueberries, the three best plots in the spruce forest (numbers 11, 12 and 23) occurred on relatively dry sites. However, the summer of 1965 was exceedingly wet and these sites were probably not as dry as they would have been during most years. In addition to producing the most blueberries, these plots also produced the largest ones as indicated in the "weight per 100" column. Plots 1 and 2 were located at the edge of an area that was burned in 1948 or 1949. Blueberry patches in the vicinity of these two plots had produced well in 1964 but were noticeably poorer in 1965. It is felt that the hail was at least partly responsible as these occurred in fairly open situations near timberline.

In the deciduous forest type, plots 3 and 4 also occurred in the above burn but were farther down the slope in the protection of willows and aspen and birch saplings. These two plots, which comprised the best and fourth best blueberry producers among all of the 33 plots sampled, occurred in only two of many good berry patches in the immediate area. There was much evidence of use of this area by bears in both 1964 and 1965 as there was also in another, much larger burn about 100 miles up the Elliott Highway.

As was mentioned earlier, the real strength of the deciduous plots was the cranberry production in a few plots, e.g., numbers 20, 21, 22, and 25, in the bottomland aspen forest. The lowest producers in the deciduous forest type, plots 15, 16, and 19, were characterized by a fairly dense understory growth of plants such as *Ledum* and *Rosa* in the first two and *Salix* and small *Picea* in the other. These plants occurred sparsely or were absent in the good plots mentioned above.

The assumed effects of the hailstorms on the open tundra plots has already been discussed. The best producing plots in the tundra type, numbers 5, 6, 27, and 32, all occurred below timberline in nearly treeless, tussocky muskeg.

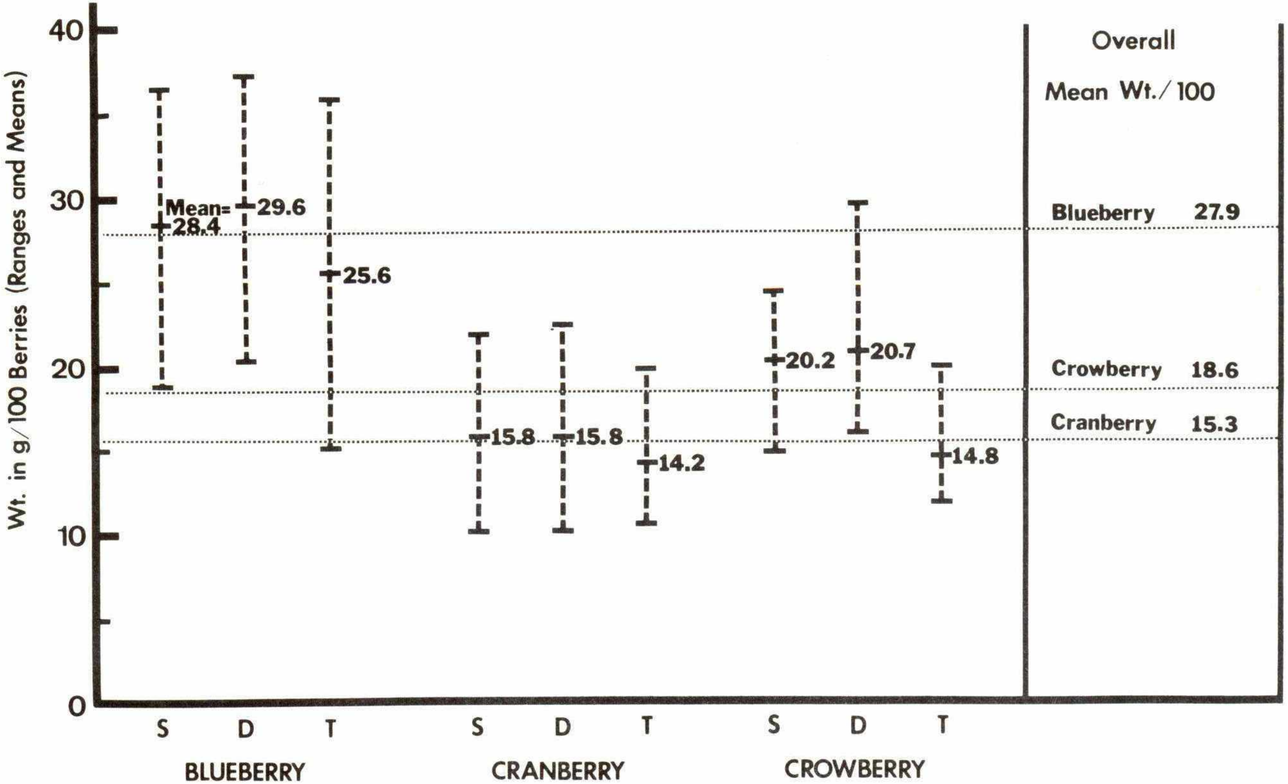
Nutritional analyses were not made during this study. The only measure of food quality that was obtained involved the weights of the three berry species from the Deadwood

Creek samples. As shown in Figure 7, blueberries consistently provided the greatest weight of food per berry with values roughly 35 percent higher and 45 percent higher than those for crowberries and cranberries respectively. Blueberries are characteristically juicier than the other two species and their greater weight is no doubt due, at least in part, to this greater moisture content. In addition to stems and seeds, most of the fleshy skin and much of the pulp of even crushed berries seems to pass through a bear's digestive tract with little change. Thus, it seems likely that the greatest amount of nutrition per berry is derived from the juice. If this is true, then the juicier a berry is, the better it is for the purposes of a bear. This suggests why crowberries and cranberries do not form a very important part of the bear's diet until blueberries are no longer available. Other juicy berries such as *Viburnum* are important in local areas of abundance but, viewing the interior as a whole, are not nearly as available as blueberries because of more restricted distribution.

Quantitative Utilization Study

During the stomach contents analyses, an attempt was made to determine numbers of berries consumed by bears.

Figure 7. Blueberry, lowbush cranberry, and crowberry weights from three habitat types: Spruce forest (S), Deciduous forest (D), and Tundra (T). Sampling done 12 Aug. through 18 Aug., 1965, at Deadwood Creek, Alaska.



All intact berries and recognizable pieces of berry skin were counted in the various samples and an estimate of numbers for the total stomach was calculated from these samples. The results are probably conservative because bits of skin too small to count always remained in each sample, and these probably represented a few berries that would not be considered in extrapolation of the total. One medium-sized, young sow had 3,070 cc of material in her stomach, including an estimated 12,100 blueberries (the largest total calculated in this study). This animal also had a large number of berries in her intestines, and observations and implications from this study have led me to believe that the passage of materials, especially berries, through a bear's digestive tract is very rapid. Overall, the point to be made is that one bear can apparently eat an awesome number of berries. As was stated, this case under consideration involved the largest berry total found during this study, but no data for large bears, which presumably could have eaten more, were obtained.

Referring back to the berry production samples (Table 11) it can be shown that even in the best berry patch sampled (Plot No. 4 in the deciduous burn) the above bear would have had to eat every berry from slightly over 20 m^2 of the patch to obtain the number of berries found in her stomach. In the best blueberry producing habitat at

Deadwood Creek (spruce forest, see Figure 6), the animal would have had to clean over 120 m^2 of average-production patches to obtain its meal. It has been my experience that a bear will quit a berry patch before there is any danger of the berry supply there being exhausted, thus the bear would probably have fed over greater areas in both situations.

Conclusions

Summarily, with respect to the relationship between bears and berries in interior Alaska, a number of hypotheses emerge. Most of the fat reserve which a bear apparently needs for successful wintering seems to be built up in the fall. The simple sugar solutions in the juices of various berries available at that time comprise what is probably one of the most desirable forms of food which could be ingested because only a minimum of time and energy is required for digestion. If processing of a berry involves little more than extraction of the juice, then fairly large quantities can be processed per unit of time, and availability of suitable berries becomes a very important factor in determining the amount of fat deposition which can occur.

Of the widely distributed berries in interior Alaska, blueberries, as has been discussed, seem to possess characteristics which make them the most suitable as fall bear food. At least, as the food habits work showed, they are by far the most widely used food while they are available. Because such large quantities of these berries are required, it should be expected that there is a level of blueberry abundance, within a given patch or in a broad area as a whole, below which a bear cannot get sufficient numbers fast enough. When this situation is encountered in the interior of Alaska, as will be mentioned in the concluding section, the bear apparently seeks better blueberry patches or other food sources instead of turning immediately to other berry species.

It was noticed that the other fairly common berry species such as lowbush cranberries, crowberries and bearberries, when found in stomachs and scats, maintained a higher proportion of intact (as opposed to collapsed and/or broken) berries than do blueberries, thus suggesting that they are less efficiently used by bears. It is not known whether or not a bear can get fat on these berries, although the available evidence seems to suggest that they do not, or at least do so only rarely. In 1963, blueberry production was low in some parts of the interior, but other berries were reportedly abundant. At the same time, incidence of reports of "thin" bears was unusually high.

The overall implication is that interior Alaskan black bears are dependent, at least to an extent, upon blueberries. This dependence seems to be due largely to a lack of suitable substitutes. Good qualitative and quantitative berry studies and a detailed investigation of the physiology of black bear digestion are needed to provide really conclusive answers.

PREDATION

Bears as Potential Predators

The role of the black bear as a predator upon other wild vertebrates is not clear. In the history of the subject in Alaska, black bears have often been accused and condemned, but the evidence offered has been circumstantial more often than it has been direct.

It is fairly well known that preference and availability are most important among the factors which determine just what an animal will eat. Though it is seldom possible to establish the relative importance of each for a particular food item, general conclusions may often be drawn inferentially. With respect to bears, the prediction that green vegetation would occur in a given food habits sample unit collected in spring and early summer could be made with relative confidence. Similarly, one could be fairly certain that a sample unit collected later in the year would contain fruit material. Obviously the incidence of these materials is strongly correlated with availability. No such prediction can be made for the incidence of vertebrate animal material.

No matter what else a particular bear may have been eating, succulent Equisetum in the spring or sweet, juicy berries in the fall, it apparently would always stop momentarily to investigate and usually to swallow anything that even vaguely hinted of meat--bird wings, hare feet, and so forth. A large bull moose that died on a hilltop in early September of 1965 was immediately utilized by bears even though blueberries were exceedingly abundant in the area. The conclusion reached by this investigator is that bears prefer meat over anything else. They will eat it whenever they can obtain it, but apparently they can not obtain it consistently.

Though endowed with many of the tastes and behavioral tendencies typical of the Carnivora, bears are probably the least carnivorous members of the order. The evolution of the ursids, which are said by Young (1962) to have arisen from canids in about the Miocene epoch, seems to have involved at least two trends. The first of these, reduced ability in pursuit and capture of land animal food, is reflected in the development of plantigrade limbs and the large bulky form characteristic of bears. Though these animals can move very quickly, they can do so only over short distances. It is implied that surprise is one of the most important components of a bear attack, and observations of most successful predation attempts (by both grizzlies and black bears) tend to support this. I would guess that the peculiar set of circumstances which would enable an animal the size and shape of a bear to stage a surprise attack occurs relatively rarely.

The other prominent trend in the evolution of bears has involved modifications of the digestive tract which have increased efficiency in the use of plant food. First considering the dentition, the teeth adapted for shearing flesh in other carnivores, the so-called carnassials, are not developed as such in bears. The sharp-cusped cheek teeth of the canids have given way in bears to the flattened bunodont type, adapted for crushing.

Considering soft parts, it is common knowledge that herbivores typically have longer intestines than do carnivores because of the greater difficulty involved in digestion of plant materials. Table 12 lists intestine lengths for 15 interior Alaskan black bears. The intestines of two European brown bears (*Ursus arctos*), a male and a female, measured 11.40 m and 15.00 m respectively according to Couturier (1954). The general magnitude of values given here for two species of bears is at least twice as great as the following rough measurements which I obtained from

Table 12. Length of intestines in 15 adult[a] black bears from interior Alaska.

Specimen Number	Sex	Size of Bear	Intestine Length (m)
2	M	small	8.48
3	F	medium	10.86
7	F	small	9.50
8	F	medium	11.05
9	F	medium	14.54
10	F	medium	10.74
12	M	small	10.07
13	M	small	10.38
105	M	medium	13.34
110	F	small	13.04[b]
112	M	medium	13.38
114	M	large	13.71
118	F	small	7.14[b]
126	F	small	12.92[b]
131	F	medium	10.83
	Mean (males--all from formalin)		11.56
	Mean (females--fresh)		11.03
	Mean (females--from formalin)		11.25
	Mean (all 9 females)		11.18
	Mean (all 15 bears listed)		11.32

[a]Adult includes all bears except cubs-of-the-year.
[b]Intestines measured fresh; all others had been preserved in 10 percent formalin.

four wolf (Canis lupus) specimens autopsied by the Alaska Department of Fish and Game.

Male	4.00 - 4.25 m
Male	6.00 - 6.25 m
Female	5.00 - 5.25 m
Female	5.25 - 5.50 m

To keep this discussion in perspective, bears are apparently the carnivores best adapted for using plant food. Yet the relatively undigested aspect of plant materials in bear feces suggests that their efficiency in this respect is still quite low, especially in comparison with the true herbivores.

Alaskan Bears as Actual Predators

Following is a collection of our actual knowledge of black bear interrelationships with specific prey groups in interior Alaska. Recent Alaskan literature dealing with the various, potential prey species and interviews with Alaskan outdoorsmen have served as my source materials.

Rodents. As indicated by Wright (1910), the black bear is quite unlike the grizzly in that it will seldom, if ever, subject itself to the major task of digging out a marmot or a ground squirrel. Though Norway rats (Rattus norvegicus) and house mice (Mus musculus) undoubtedly fall prey to bears in certain artificial situations, in interior Alaska microtines are probably the only rodents taken regularly under natural conditions. A brown lemming (*Lemmus trimucronatus*) in a scat from alpine tundra and two northern bog lemmings (*Synaptomys borealis*) in the stomach of a bear killed in the marshes of Minto Flats were the only microtines represented in food habits analyses made during this study. However, one hunter reported seeing a "mouse" in the stomach of a bear he killed along the Chena River, and from his description it appeared that this was probably a red-backed vole (*Clethrionomys rutilus*). This species is the most common microtine in bear habitat, i.e., forested areas, in the interior.

Many veteran Alaskan trappers have reported black bear predation on beavers (*Castor canadensis*), but it would be difficult to establish any type of frequency from these somewhat prejudiced reports. Hakala (1952) reported an instance of a bear killing a beaver that was confined in a Bailey livetrap, but he didn't indicate belief that this occurs commonly under natural conditions. Libby (1954) classifies the occurrence as "probably occasional."

Lagomorphs. As was reported in the food habits section, snowshoe hare material appeared commonly in stomachs and scats but never in sufficient quantity to suggest predation. The only hares I know of that were killed by bears were two live-trapped individuals during O'Farrell's (1960) study.

Cervids. Only two cervids, moose (*Alces alces*) and barren ground caribou (*Rangifer tarandus*) occur in interior Alaska. Contact between the latter and black bears is probably rare because of differing habitat preferences. Skoog (1956) says that bear predation on caribou is insignificant, and he implies that most that does occur involves grizzlies. I have only one report of an observed interrelationship between black bears and caribou. Biologist Joe Nava (pers. comm.), while making composition counts of portions of the Steese-Fortymile caribou calving herd in June of 1961, watched a large male black bear make several apparently serious attempts to catch caribou. A number of different bands of cows and calves were chased--all unsuccessfully. In fact, Nava said that the most striking thing about this observation was the bear's total inability to even come close.

Bear-moose relationships compose one of the most controversial wildlife subjects in Alaska. There are many experienced outdoorsmen who are certain that one of the chief causes of calf mortality is predation by bears. The idea of heavy bear predation on moose calves probably gained much of its momentum in the late 1930's and early 1940's as a result of the Kenai Peninsula situation which was much in the public eye at that time. The history of the Kenai problem, as described by Chatelain (1950), seems to boil down to an assumed cause-and-effect relationship involving juxtaposition of rising bear populations with apparently declining moose populations in the area. Several people observed bears chasing moose calves and a few witnessed kills. Biologists such as Palmer and Sarber (cited by Hosley, 1949) presented reports of bear predation and low calf to cow ratios. Scat analysis by Chatelain (1950) showed that some bears did indeed eat calf moose, but of course such a study offers no direct evidence that the feeders had been the killers. In addition, no attempt was made to distinguish between the scats of black bears and those of brown bears in Chatelain's study.

As has been stated in other sections, throughout May and much of June, many black bears will be found at the lower elevations, particularly along waterways and marsh areas where new succulent vegetation first becomes abundantly available. Coincidentally, it is during this time and in these areas that moose do their calving. Certainly under these conditions, the chances for predation are increased, and it probably takes only a few observations of the inevitable contacts for people to conclude that the abundance of bears on the calving grounds is no coincidence. But it should be remembered that the bears get there before the calves do, and observations and food habits analyses show that it is largely greens that are being used.

In an analysis of black bear predation on moose calves, one of the factors which should first be considered is the size and temperament of the prospective prey's mother. Certainly an angry cow moose is a formidible foe, a fact documented by an anonymous (1956) description of a large male bear-cow moose encounter in which the latter quickly gained the upper hand. However, there are at least two exceptional maternal situations: LeResche (1966) noted that a cow moose with twin calves is content as long as one calf is by her side and apparently is not too likely to put herself out to protect the other one. R. A. Rausch (pers. comm.) says that some cows are too timid to try to protect their calves from humans and that they may react the same way to predators. Unfortunately for bears, timid cows and cows with twins are not common, and I doubt whether many black bears are big enough and bold enough to face the usual defense.

It seems likely that most moose calves eaten by bears are available without having to be killed by the bears, for, as stated by Rausch (1959), "Moose calves seem to be accident prone, and succumb to drowning, falls, cars, dogs, and possibly to abandonment." Add to these accidents such as that recorded by LeResche (1966) in which death of a calf apparently resulted from an accidental kick by its mother, and it can be seen that the statement by Chatelain (1950) that during his study "no dead calves were seen that had not been eaten by bears, and none were reported," probably means, at best, that bears are quick to respond to an opportunity to obtain carrion.

Finally, it seems safe to assume that bears and moose have been using lowlands together in the springtime for a long time. It would seem that if the two have had violent interactions as often as is supposed by some, they would have developed natural "attitudes" toward one another that would be reflected in their behavior. Lucas (1932) and LeResche (1966) observed that moose usually showed little, if any, alarm at the presence of black bears although they reacted strongly to the presence of brown bears. The obvious implication is that black bears are not considered to be much of a threat to the moose, while brown bears, which have been observed to kill adult as well as calf moose (LeResche, 1966) definitely are.

In all, the bear-moose situation in Alaska seems to be similar to that in Ontario, summed up by Peterson (1955) as follows, "Although bears undoubtedly kill a certain number of calves in Ontario, little direct evidence has been encountered to substantiate the general belief in the seriousness of the predation." The seriousness of the predation is measured by its actual effect upon the prey population. About this, R. A. Rausch (pers. comm.) says that in Alaska, observed moose calf survival in most areas seems to follow fairly regular patterns and appears to be independent of the density of local black bear populations.

Other Ungulates. H. J. Johnson (1958) reports an observation (by J. B. Hakala) of a sow black bear killing a Dall sheep (*Ovis dalli*) lamb. In view of this, there may be some contacts between bears and sheep in the interior, but these are probably rarer than are contacts with caribou.

Birds. Reports of black bears' attempts, both successful and unsuccessful, to obtain nestling birds and/or eggs have been given by Murie (1954), Taverner (1928), Dixon (1927), and Rowan (1928). The last of these authors, on the basis of reliable reports from three or four observers, concludes "there seems no doubt that bears, certain individuals at all events, will systematically work the edges of lakes and for a time live almost exclusively on ducks' eggs." This seems to be one of the few published records of bear predation on waterfowl eggs, a rather strange circumstance since this predation appears to be very real.

Schneider (pers. comm.) said that many duck nests were lost to predation by bears in the Tetlin, Alaska, area in 1964. Waterfowl biologist, P. Shepherd (pers. comm.) says that as duck egg predators, black bears are probably second only to mew gulls (*Larus canus*) in interior Alaska. He indicates that diving ducks, particularly scaups (*Aythya* spp.), are hardest hit because they nest near the water's edge on the floating mats where bears often go to obtain the succulent greens that can be found there.

BEAR-HUMAN INTERRELATIONSHIPS

The most extensive section of the black bear bibliography compiled by Tigner and Gilbert (1960) is entitled, "Economic value and control." Trouble with black bears has been a part of the rural and new urban scene for so long it should probably be considered part of the American heritage. Most problems have centered around bears' choices of foods. As has been discussed, bears are typically opportunistic and, unfortunately, many of the food items that bears prefer are the same ones that humans prefer. Thus, bears have been accused of, and have been guilty of, stock and game killing, a variety of agricultural, horticultural, and apicultural depredations, and offenses such as "breaking and entering" and pantry larceny.

In the interior of Alaska, little opportunity exists for many of the above problems to occur, but there are substitutes. It can be depended upon that bears will cause trouble around native fish camps, trappers' caches, and homestead cabins each year. Nearly every pioneer Alaskan I have talked to recalls having lost at least one "outfit" to rampaging bears during his career "in the bush." Many bears become nuisances in garbage disposal areas. Most of the tourist lodges and roadhouses in the interior receive at least a few bear visits each year, and problems often develop from feeding of these bears by tourists. Fed bears become increasingly bolder, and proprietors of these establishments usually end up killing such bears to prevent the serious consequences which often result in similar situations in some of our national parks.

The summer of 1963 will be long-remembered in interior Alaska as the year of the bears. During that time the ordinary problems mentioned above were seemingly at their worst in terms of frequency of occurrence. But the real cause for concern was the "unnatural behavior" exhibited by bears in five, allegedly unprovoked attacks upon humans. These incidents which occurred between 21 July and 19 August are reported in detail by Erickson and Rausch (1964). Popular accounts are given by Beebe and Johnson (1965) and Vorys (1964).

Another unusual aspect of bear behavior in 1963 was the tendency to concentrate in certain areas. Neil Argy (pers. comm.) reported seeing 44 bears feeding together in the Clear Missile Site garbage dump. Bears were abundant in and around the Murphy Dome Missile Installation throughout the summer. In late fall, large numbers of bears could be found in the high, moist tundra and burned forest area between about mile 95 and mile 115 on the Elliott

Highway. One hunter said that he and his wife saw 14 bears on each of 2 days in this area. On an evening in mid-September, biologist Larry Ellison and the investigator counted eight dead bears in hunters' camps within a mile and a half stretch of this section of road. Meanwhile, between 40 and 45 bears were reported killed in or near the small community of Manley Hot Springs during the summer. Approximately 80 miles down the Tanana River, in the village of Tanana, the reported summer bear kill was 38.

Examination of Table 13 shows that the success of bear hunters soared in the fall of 1963. Two factors which could have been involved in producing this success are an increased interest in obtaining bears for trophy purposes during that time and/or a larger bear population in 1963 than in other years. Although both could have been active to some extent, the apparently stable take during the spring (the actual bear trophy season) over the last three years shown indicates that there is no real reason for suspecting either. Thus a third factor, increased availability of bears to hunters (for reasons which will become clear later in this discussion), was likely the factor chiefly responsible.

Despite the fact that the attacks on humans, the mass invasions of villages, the widespread occurrence of nuisance bears in fish camps, tourist installations, and home-

Table 13. Numbers of black bear hides received by a taxidermy shop[a] over several years[b].

Time Period	1959	1960	1961	1962	1963	1965
1 Jan.- 30 June	28	37	13	41	47	49
1 July- 31 Dec.	53	45	33	65	146	42
Totals	81	82	46	106	193	91

[a]Shop located in basement of Eskimo Museum, Mile 6 Richardson Highway, has been under three separate ownerships during the time shown: Haynes and Haynes, Glenwood Taxidermy, and Northland Taxidermists. Data for 1959-1963 from files of Alaska Dept. of Fish and Game, and that for 1965 obtained by the investigator.
[b]Data for 1964 not available.

steads, and the high availability of bears to hunters were all happening concurrently, it was the attacks alone that received attention. Hypothetical explanations for black bear behavior in 1963 appeared, but these dealt almost exclusively with the subject of the attacks. Some of these hypotheses, together with my appraisal of each, follow.

As has been noted in accounts of the attacks, all of the bears involved which were killed proved to be "large males in good condition." Beebe and Johnson (1965) suggest that these bears had been thwarted during the breeding season and their attacks resulted from consequent frustrations. If this were true, why would the situation have been limited to 1963? And why would the frustrated males have been the really large ones? Finally, is it reasonable to expect that these so-called frustrations would hang on for a month or more after the breeding season? I doubt seriously whether sexual activity, or a lack of it, had anything to do with any aspect of the 1963 bear situation.

The author of an outdoor magazine article pointed out that berries constitute the raw material for wine and intimated that the attacking bears may have been inebriated on fermented berries to the extent that they were not aware of what they were doing. This idea, like the previous one, suffers from its inability to explain why it should occur in 1963 but not in other years. Further, many of the attacks came too early in the year for fermented berries to have been available on the bushes, and it is unlikely that berries stay inside a bear long enough for fermentation to occur there.

Disease was suggested as another possible reason for the bears' unusual behavior, and it can not be completely ruled out. But, as Erickson and Rausch (1964) have indicated, all the bears involved appeared to be in good health and no gross abnormalities were noted. All tested negative for rabies.

As has been mentioned elsewhere in this paper, blueberry production in 1963 was apparently below "normal" in many areas of interior Alaska, and in the minds of many people this was the factor behind the year's bear problems. However, as a study of interviews with victims of the bear attacks shows (Beebe and Johnson, 1965; Vorys, 1964) the significance of the lack of blueberries was probably improperly interpreted. The feeling among many seems to be simply that the bears were hungry in the absence of their natural food and had decided to ease their hunger pangs by eating people. No aspect of the 1963 attacks would tend to support this view. Indeed, as pointed out by Erickson (Erickson and Rausch, 1964) the fact that the body of J. W. Strandberg (the only fatality among the bear attack cases) had not been dragged to cover, buried, or otherwise treated as meat ordinarily is by bears indicates that food-getting was very probably not a motive for the attack.

In view of the great rash of other bear problems encountered in 1963, it seems unrealistic to consider the subject of the attacks as something separate and unrelated. Consequently, the 1963 situation as a whole will be discussed here in the light of evidence accumulated during this study. It is my contention that food supply was the prime factor, even though some professional biologists as well as a few authors of popular articles have insisted that this couldn't have been so.

Several of the sources opposing food supply as a factor have drawn on information received from Dr. Arvo Kallio, horticulturist with the University of Alaska Agricultural Extension Service. Dr. Kallio, who had made general observations of berry abundance and distribution in interior Alaska for a number of years prior to 1963 (and is therefore probably a reliable source), reported the following three facts according to Erickson and Rausch (1964):

1. Blueberries were generally scarce during 1963, "though not exceptionally so."
2. There were some areas of high abundance of blueberries.

3. Lowbush cranberries were abundant.

Dr. Kallio's observation that blueberries were generally scarce is supported by the recollections of the many berry-picking Alaskans whom I interviewed. The qualifying phrase, "though not exceptionally so," reflects one man's subjective appraisal and is probably not too meaningful. It seems possible that the level of blueberry abundance critical to bears may be higher than the level which Dr. Kallio would consider exceptionally low.

With respect to Dr. Kallio's second point, there can be no doubting the fact that there were some areas in which blueberries were very abundant. An example of such an area, from my own observations and interviews, was the alpine country between mile 95 and mile 115 on the Elliott Highway. Recall that this area yielded many bears to hunters and was the area in which many more animals were seen. The apparent concentration in this area, then, is similar to the concentrations noted around villages and in garbage disposal sites in that it occurred at a concentrated source of food.

It was found during the food habits analyses that cranberries were used by bears only rarely during the blueberry seasons of 1964 and 1965. It is not known to what extent cranberries were used during the blueberry scarcity of 1963, but there are indications that, even if they were used extensively, they did not compose a suitable substitute. In an intra-departmental memorandum (from the files of the Alaska Dept. of Fish and Game), R. A. Rausch states,

> While adequate information is again lacking on the relative frequency of "thin versus fat" bear for 1963, reliable reports of emaciated bear are numerous. These reports include those from the villages where carcasses were not used because they lacked fat.

Bears in poor condition plus bears congregating to sources of other (non-cranberry) foods suggest that Kallio's observation of a high cranberry crop in 1963 has little bearing on the problem.

Overall, three points stand out:

1. During the two years studied (1964 and 1965) blueberries constituted, by far, the most important bear food item between late July and early September. There is no reason to believe that these two years were unusual in this respect.

2. In 1963, bears were generally hungry as evidenced by the congregation of many to food sources and by the poor condition of a number of these animals. A startlingly high incidence of bear problems resulted.

3. In 1963, blueberry production was lower than what might be considered "normal."

The summer of 1965 provides a comparison of the converse situation as a year during which blueberry production throughout interior Alaska was considered by most people to be exceedingly high. Bear problems after the middle of July were almost non-existent (I heard of none). Bears appeared to be widely dispersed and were not available to hunters to any extent until well into September when the deciduous trees and shrubs had lost most of their foliage, thus increasing in-forest visibility. Even then bears were rarely available to road hunters. As veteran outdoorsman, Don Draper, (pers. comm.) had told me earlier in the fall, during a good berry year bears don't have to work so long for their food and can "lay up in the brush" during most of the daylight hours.

On a trip up the Elliott Highway on 17-19 September, no bears or bear sign were seen on or near the road. Villagers and homesteaders said that bears were scarce. However, a hunter with a spotting scope told me that, within the period of about 2 hours, he had seen from three to five different bears (depending upon possible duplication) in the 5 or 6 square miles of a forest burn which he could search from his lookout. Searching the same area, I found two different animals in about one-half hour's time. Hikes of a half mile or more from the road revealed that bear sign was really quite abundant. In short, the lack of bears which many people had reported was more apparent than real, and it seems to have been as related to blueberry abundance as the apparent bear abundance seems to have been related to blueberry scarcity in 1963.

A study of the literature shows that bear problems have accompanied food scarcities before. Babcock (1927), writing about Massachusetts black bears, says, "...it was only in the years when berries, acorns, and nuts were scarce that bears destroyed soft corn, pigs, and sheep to any extent." A picture of a black bear cub in a Wisconsin school yard is accompanied by the following anonymous (1957) caption, "R. F. Wendt, game manager at Ladysmith (Wisc.), believes that a shortage of wild berries may cause bears to hunt provisions in town during late summer." Munro (1945) in British Columbia and Schorger (1946) in Minnesota noted suddenly large bear populations in their respective areas, and both felt that shortages of natural foods in the mountains were responsible.

Closer to home, on the Kenai Peninsula, 1958 was proclaimed "a black bear year" by H. J. Johnson (1958), refuge manager at the Kenai National Moose Range. He reported that there were "at least two black bear for each garbage can," and ten animals were shot in areas where it was believed necessary to protect children or livestock. Johnson felt that, "This situation was brought about by a high bear population, coupled with a shortage of natural food--berries and fish." During the following year, things were different. In his narrative report, Johnson's successor, J. B. Hakala (1959) asserts,

> Black bear are more numerous than ever, five or six animals being seen on every flight. Fewer were seen within the homestead area, largely due to the excellent berry crop produced this year, providing an abundance of food. No black bear kills have been reported where it was found necessary to protect life or property.

My justification for including the most sensational incidents of 1963, the bear attacks, with the many other bear problems of the year has already been discussed. It should be apparent that most of the problems resulted from bears' responding directly to what I have considered to be the causative factor, i.e., the scarcity of blueberries. Lacking food locally, many animals sought it elsewhere and caused trouble where they found it. The relationship between this factor and the bear attacks may have been less direct. It seems possible that bears may have become irritible and more easily provoked under the stress of direct competition for food. (Certainly the concentrations of animals noted in some areas must be labelled abnormal, for bears are generally not considered to be gregarious.) However, in at least four out of five of the attack cases (the only exception being the attack on L. Bidlake) the attacking bears were probably attracted by the smell of food, for these incidents occurred at camps of one sort or another, and it is hard to conceive of a human camp which would be completely devoid of the smell of food.

LITERATURE CITED

American Ornithologists' Union. 1957. Check-list of North American birds. 5th ed. American Ornithologists' Union. Ithaca, New York. 691 p.

Anderson, J. P. 1959. Flora of Alaska and adjacent parts of Canada. The Iowa State Univ. Press, Ames, Iowa. 543 p.

Anonymous. 1956. Moose vs. bear. Wyo. Wildl. 20(9):37.

Anonymous. 1957. What's going on? Wisc. Cons. Bull. 22(12):40.

Babcock, H. L. 1927. Early Massachusetts records of the black bear. Bull. Boston Soc. Natur. Hist., No. 45. p. 3-5.

Beebe, B. F. and J. R. Johnson. 1965. American bears. David McKay Co., Inc. New York. 182 p.

Bennett, L. J., P. F. English, and R. L. Watts. 1943. The food habits of the black bear in Pennsylvania. J. Mammal. 24(1):25-31.

Boone and Crockett Club. 1964. Records of North American big game. Holt, Rinehart and Winston, New York. p. 332-337.

Buckley, J. L. and W. L. Libby. 1957. Research and reports on aerial interpretation of terrestrial bioenvironments and faunal populations. Arctic Aeromed. Lab. Tech. Rep. 57-32. Ladd Air Force Base (now Ft. Wainwright Army Base), Fairbanks, Alaska. 105 p.

Chatelain, E. F. 1950. Bear-moose relationships on the Kenai Peninsula. Trans. N. Am. Wildl. Conf. 15:224-233.

Cottam, C. A., A. L. Nelson, and T. E. Clarke. 1939. Notes on early winter food habits of the black bear in George Washington National Forest. J. Mammal. 20(3):310-314.

Couturier, Marcel A. J. 1954. L'ours brun. Grenoble. 904 p.

Dixon, J. 1927. Black bear tries to gnaw into a woodpecker's nest. Condor 29:271.

Drury, W. H., Jr. 1952. The cyclic development of bog flats in interior Alaska. Unpublished Ph.D. Thesis, Dept. of Biol., Harvard Univ., Cambridge, Mass. 87 p.

Erickson, A. W. 1965. The black bear in Alaska. FA Proj. Report, Vol. V: Proj. W-6-R-F, Work Plan F. Alaska Dept. Fish & Game, Juneau. 19 p.

Erickson, A. W., and R. A. Rausch. 1964. Black bear attacks on man. Unpublished manuscript, personal files of R. A. Rausch, Alaska Dept. Fish & Game.

Erickson, A. W., J. Nellor, and G. A. Petrides. 1964. The black bear in Michigan. Mich. State Univ. Agr. Exp. Sta. Res. Bull. No. 4. East Lansing, Mich. 102 p.

Fernald, M. L. 1950. Gray's Manual of Botany. 8th ed. Amer. Book Co., New York. 1,632 p.

Gilbert, D. L. 1951. Economics and related biology of the black bear in Colorado. Unpublished M.S. Thesis, Colo. A & M College, Ft. Collins. 164 p.

Hakala, J. B. 1952. The life history and general ecology of the beaver (<u>Castor canadensis</u> Kuhl) in interior Alaska. Unpublished M.S. Thesis, Univ. of Alaska, College, Alaska. p. 120-121.

Hakala, J. B. 1959. Black bear. <u>In</u> Kenai Refuge Narrative Report (May-August, 1959). Kenai National Moose Range, Kenai, Alaska. p. 11.

Hall, E. R. and K. R. Kelson. 1959. The mammals of North America. 2 vol. The Ronald Press Co., New York. 1,083 p.

Harlow, R. F. 1962. Facts about Florida bear. Florida Wildl. 15(12):12-17.

Hosley, N. W. 1949. The moose and its ecology. U.S. Fish and Wildl. Service Wildl. Leafl. No. 312. 51 p.

Johnson, H. J. 1958. Black bear. <u>In</u> Kenai Refuge Narrative Report (May-August, 1958). Kenai National Moose Range, Kenai, Alaska. p. 11-14.

King, J. M., H. C. Black, and O. H. Hewitt. 1960. Pathology, parasitology, and hematology of the black bear in New York. New York Fish and Game Journal 7(2):99-111.

LeResche, R. L. 1966. Behavior and calf survival in Alaskan moose. Unpublished M.S. Thesis, Univ. of Alaska, College, Alaska. 84 p.

Libby, W. L. 1954. A basis for beaver management in Alaska. Unpublished M.S. Thesis, Univ. of Alaska, College, Alaska. p. 23, 31.

Lucas, Henry. 1932. A report of a special investigation of the Kenai Peninsula moose herds, May 7 to July 27, 1932. Files of Alaska Coop. Wildl. Research Unit, College, Alaska. 6 p. mimeo.

Lutz, H. J. 1956. Ecological effects of forest fires in the interior of Alaska. U.S. Dept. Agr. Tech. Bull. No. 1,133. 121 p.

Matson, J. R. 1951. Litter size in the black bear. J. Mammal. 33(2):246-247.

Munro, J. A. 1945. Preliminary report on the birds and mammals of Glacier National Park, British Columbia. Can. Field-Naturalist 59:175-190.

Murie, O. J. 1954. A field guide to animal tracks. Houghton Mifflin Co., Boston. p. 32-34.

O'Farrell, T. P. 1960. Snowshoe hares in Alaska. I. Home range and aspects of population and natural history in interior Alaska. Unpublished M.S. Thesis, Univ. of Alaska, College, Alaska. p. 68-69.

Patrick, N. D. 1961. Estimating total weights of black bears from carcass weights. J. Wildl. Mgmt. 25(1):93.

Peterson, R. L. 1955. North American moose. Univ. of Toronto Press, Toronto. 280 p.

Rausch, R. A. 1959. Some aspects of population dynamics of the railbelt moose populations Alaska. Unpublished M.S. Thesis, Univ. of Alaska, College, Alaska. p. 60-61.

Rausch, R. L. 1961. Notes on the black bear, Ursus americanus Pallas, in Alaska, with particular reference to dentition and growth. Zeitschrift fur Saugertierkunde, Bd. 26, H. 2, S. 65-128.

Rausch, R. L. 1963. Geographic variation in size in North American brown bears, Ursus arctos L., as indicated by condylobasal length. Can. J. Zool. 41(1):33-45.

Rowan, W. 1928. Bears and birds' eggs. Condor 30(2):246.

Rowan, W. 1947. A case of six cubs in the common black bear. J. Mammal. 28(4):404-405.

Rust, H. J. 1946. Mammals of Northern Idaho. J. Mammal. 27(4):308-327.

Schneider, K. B. 1965. Growth and plumage development of ducklings in interior Alaska. Unpublished M.S. Thesis, Univ. of Alaska, College, Alaska. 67 p.

Schorger, A. W. 1946. Influx of bear into St. Louis County, Minnesota. J. Mammal. 27(2):177.

Skinner, M. P. 1925. Bears in the Yellowstone. A. C. McClurg & Co., Chicago. 158 p.

Skoog, R. D. 1956. Range, movements, population and food habits of the Steese-Fortymile caribou herd. Unpublished M.S. Thesis, Univ. of Alaska, College, Alaska. p. 88-89.

Spencer, H. E. 1955. The black bear and its status in Maine. State of Maine Dept. of Inland Fisheries and Game, Game Div. Bull. No. 4. 55 p.

Taverner, P. A. 1928. Bears and hawks. Condor 30(1):157.

Tigner, J. R. and D. L. Gilbert. 1960. A contribution toward a bibliography on the black bear. State of Colo. Dept. of Fish and Game Tech. Bull. No. 5. 42 p.

Tisch, E. L. 1961. Seasonal food habits of the black bear in the Whitefish Range of northwestern Montana. Unpublished M.S. Thesis, Univ. of Mont., Missoula. 108 p.

Vorys, Martin. 1964. Black bear war. Sports Afield 151(6):26-29, 134, 136, 138, 140, 142, 144.

Watson, C. E. 1959. Climates of the states: Alaska. Climatography of the United States No. 60-49. U.S. Government Printing Office, Washington, D. C. 24 p.

Wilde, S. A. and H. H. Krause. 1960. Soil-forest types of the Yukon and Tanana valleys in subarctic Alaska. J. Soil Sci. 11(2):266-279.

Wright, W. H. 1910. The black bear. Charles Scribner's Sons, New York. 127 p.

Young, J. Z. 1962. The life of vertebrates. 2nd ed. Clarendon Press, Oxford. p. 685-686.